PB81-910220

U.S. DEPARTMENT OF THE INTERIOR

OFFICE OF WATER RESEARCH AND TECHNOLOGY

# SELECTED WATER RESOURCES ABSTRACTS

VOLUME 14, NUMBER 20
OCTOBER 15, 1981

W81-04651 -- W81-05000
CODEN: SWRABW

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# SELECTED WATER RESOURCES ABSTRACTS

A semimonthly publication of the Office of Water Research and Technology,
U.S. Department of the Interior

**VOLUME 14, NUMBER 20**
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As the Nation's principal conservation agency, the Department of the Interior has responsibility for most our our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.

# PREFACE

**Selected Water Resources Abstracts,** a semimonthly journal, includes abstracts of current and earlier pertinent monographs, journal articles, reports, and other publication formats. These documents cover water resources as treated in the life, physical, and social sciences and the related engineering and legal aspects of the characteristics, supply condition, conservation, control, use, or management of water resources. Each abstract includes a full bibliographic citation and a set of descriptors which are listed in the **Water Resources Thesaurus.** The abstract entries are classified into 10 fields and 60 groups similar to the water resources research categories established by the Committee on Water Resources Research of the then Federal Council for Science and Technology.

**Selected Water Resources Abstracts** is designed to serve the scientific and technical information needs of scientists, engineers, and managers as one of several services of the Office of Water Research and Technology. The cumlative SWRA file from 1968 and monthly updates are available also in magnetic tape through lease from NTIS.

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Comments and suggestions concerning the contents and arrangement of this bulletin are welcome.

Office of Water Research and Technology
U.S. Department of the Interior
Washington, D.C. 20240

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# SELECTED WATER RESOURCES ABSTRACTS

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### 1A. Properties

**OPTIMAL ENERGY EXTRACTION FROM A HOT WATER GEOTHERMAL RESERVOIR,**
Woodward Clyde Consultants, San Francisco, CA.
K. Golabi, C. R. Scherer, C. F. Tsang, and S. Mozumder.
Water Resources Research, Vol 17, No 1, p 1-10, February, 1981. 3 Fig, 5 Tab, 20 Ref.

Descriptors: *Geothermal resources, *Energy sources, Reservoirs, Hydrothermal studies, Thermal properties, Pumping, Hot springs.

This paper is concerned with the extraction of energy from a hot water geothermal field. The major question is concerned with what extraction rate maximizes the net discounted value of energy extracted when the cooled brine is reinjected. A decision model is presented which computes the optimal fluid pumping rate and reinjection temperature and the project life consistent with maximum present worth of the net revenues from sales of energy for space heating. With the passage of time the real value of product energy is assumed to increase as is the cost of energy used in pumping the aquifer. Use of a hydrothermal model that relates hydraulic pumping rate to the quality of remaining heat energy in the aquifer implements the economic model. A numerical application is made to space heating, which shows that the profit-maximizing extraction rate increases with interest rate and decreases as the rate of rise of real energy value increases. The economic life of the reservoir generally varies inversely with extraction rate. It was demonstrated that permeability, initial equilibrium temperature, well cost and well life all affect the results. (Baker-FRC)
W81-04913

### 1B. Aqueous Solutions and Suspensions

**THE INFLUENCE OF THE POROUS SUBLAYER ON THE SALT REJECTION AND REFLECTION COEFFICIENT OF ASYMMETRIC CA MEMBRANES,**
Technical Univ. of Denmark, Lyngby.
G. Jonsson.
Desalination, Vol 34, No 1/2, p 141-157, July/August, 1980. 3 Tab, 10 Fig, 23 Ref.

Descriptors: *Permeability, *Membrane processes, *Selectivity, Mathematical studies, Theoretical analysis, Membranes, Semipermeable membranes, Coefficient of permeability, Calcium, Osmosis, Solutes, Selective media, Mathematical equations, Pressure distribution, Retention.

Reverse osmosis experiments were conducted in an investigation of the properties of individual layers of an asymmetric cellulose acetate membrane. In the experiments three membranes were pressurized at different intensities and exposed to a standard butanol solution. For each membrane retention curves were measured for three positions of the membrane: the skin layer facing high pressure, the porous layer facing high pressure, and the skin layer again facing high pressure. Results produced estimated values of the solute permeabilities for each layer. It was also shown that the opening of the membrane skin starts at 15 atm. A concentration gradient in the porous sublayer was revealed. The results justify theoretically derived relationships between retention and the membrane reflection coefficients. (Titus-FRC)
W81-04880

**CALCITE DISSOLUTION: AN IN SITU STUDY IN THE PANAMA BASIN,**
South Carolina Univ., Columbia. Belle W. Baruch Inst. for Marine Biology and Coastal Research.
R. C. Thunell, R. S. Keir, and S. Honjo.
Science, Vol 212, No 4495, p 659-661, May, 1981. 2 Fig, 27 Ref.

Descriptors: *Calcite, *Sea water, Thermoclines, Thermodynamics, Thermal stratification, Dissolved solids, Sediments, Panama Basin, Dissolution.

An in situ study was made of calcite dissolution in the Panama Basin. The rate of dissolution in the water column was found to increase suddenly below a water depth of about 2800 meters. This depth is the same as that at which the calcium carbonate content of surface sediments begins to decrease rapidly, i.e., the sedimentary lysocline. As this level of increased dissolution both in the water column and on the sea flood did not appear related to the transition from supersaturation to undersaturation with respect to carbonate, there may be a kinetic origin for the lysocline in this region. (Baker-FRC)
W81-04933

## 2. WATER CYCLE

### 2A. General

**METHODS AND APPLICATIONS OF DIGITAL-MODEL SIMULATION OF THE RED RIVER ALLUVIAL AQUIFER, SHREVEPORT TO THE MOUTH OF THE BLACK RIVER, LOUISIANA,**
Geological Survey, Baton Rouge, LA. Water Resources Div.
For primary bibliographic entry see Field 2F.
W81-04665

**WATER BUDGET AND MATHEMATICAL MODEL OF THE COCONINO AQUIFER, SOUTHERN NAVAJO COUNTY, ARIZONA,**
Geological Survey, Tucson, AZ. Water Resources Div.
For primary bibliographic entry see Field 2F.
W81-04672

**ENVIRONMENTAL APPLICATIONS OF MAGNETIC MEASUREMENTS,**
Edinburgh Univ. (Scotland). Dept. of Geophysics.
For primary bibliographic entry see Field 7B.
W81-04827

**RUNOFF RESPONSES TO SOIL HETEROGENEITY: EXPERIMENTAL AND SIMULATION COMPARISONS FOR TWO CONTRASTING WATERSHEDS,**
Oak Ridge National Lab., TN. Environmental Sciences Div.
R. J. Luxmoore, and M. L. Sharma.
Water Resources Research, Vol 16, No 4, p 675-684, August, 1980. 12 Fig, 4 Tab, 29 Ref.

Descriptors: *Soil properties, *Watershed models, *Runoff forecasting, Simulation analysis, Streamflow, Model studies, Water budget, Scaling, Grasslands, Soil water, Evapotranspiration, Mathematical models, Hydrologic models, Comparison studies, Chickasha, *Oklahoma.

The one-dimensional terrestrial ecosystem hydrology model (TEHM by Huff, et al., 1977) was used to compute simulated annual water budget and daily streamflows for two watersheds at Chickasha, Oklahoma. One grassy area was well-managed, the other was overgrazed. Soil hydraulic properties were scaled. Drainage and runoff were greatly influenced by changes in scaled soil properties. Evapotranspiration increased at smaller scaling values (finer soils). The overgrazed watershed, with lower evapotranspiration and hydraulic conductivity, generated more runoff. The surface runoff generated from the scaled soil frequency distributions proportionately accounted for 29 and 55% of simulated streamflows from the well-managed and overgrazed watersheds, respectively. Agreement between observed and measured streamflows was obtained by using an algorithm representing lateral subsurface flow to the streambed as a function of soil drainage rate. For both watersheds the simulated runoff from the log normal distribution of soils was closer to the measured value than the runoff from the mode, median, or mean soils. Comparisons between measured and simulated soil water contents showed significant differences, whereas the streamflows showed agreement. (Cassar-FRC)
W81-04923

**AN EVENT-BASED MODEL OF RECHARGE FROM AN EPHEMERAL STREAM,**
Arizona Univ., Tucson. Dept. of Soils, Water, and Engineering.
M. Flug, G. V. Abi-Ghanem, and L. Duckstein.
Water Resources Research, Vol 16, No 4, p 685-690, August, 1980. 3 Fig, 1 Tab, 20 Ref.

Descriptors: *Ephemeral streams, *Recharge, *Streamflow, Model studies, Arid lands, Groundwater recharge, Groundwater management, Watersheds, Hydrologic models, Runoff, Rillito Creek, *Arizona.

This paper develops a method for estimating the probability density function of annual natural recharge into an aquifer using streamflow data as input to the groundwater system. A linear transfer model defining groundwater recharge as a funtion of streamflow is postulated from stream characteristics in arid lands. The model is used to determine the distribution function for annual recharge in Rillito Creek, Tucson alluvial basin, Arizona. To improve the predictive value of the model, several changes are suggested: (1) obtain additional recharge information and generate a posterior probability density function using Bayes' rule with an appropriate likelihood function, (2) consider individual runoff durations for each season, rather than assume the same probability density function for the whole year, (3) study the influence of probabilistic model choice on recharge results, and (4) include streamflow volume by making recharge a function of flow depth and flow duration. (Cassar-FRC)
W81-04924

**HYDRODYNAMICS OF A TIDAL CREEK-MANGROVE SWAMP SYSTEM,**
Australian Inst. of Marine Science, Townsville.
For primary bibliographic entry see Field 2L.
W81-04966

### 2C. Snow, Ice, and Frost

**VEGETATIONAL CHANGE AND ICE-WEDGE POLYGONS THROUGH THE THAW-LAKE CYCLE IN ARCTIC ALASKA,**
Duke Univ., Durham, NC. Dept. of Botany.
W. D. Billings, and K. M. Peterson.
Arctic and Alpine Research, Vol 12, No 4, p 413-432, November, 1980. 7 Fig, 2 Tab, 45 Ref.

Descriptors: *Vegetation, *Succession, *Cycles, Frost action, Lake stages, Thawing, Ice wedges, Thaw-lakes, Alaska, *Arctic zone, Frozen soils, Permafrost, Iced lakes, Tundra, *Seasonal variation.

Britton's (1957) observations on the thaw-lake cycle in Arctic regions were modified by new observations following artificial drainage of two thaw-lakes in 1950. Thaw-lake cycles, which may have begun 25,000 years ago, last about 2,000 or 3,000 years. The process begins with contraction cracks in newly-exposed sediment. An ice-wedge polygon network forms when water and snow fill these cracks. Further ice-wedge development divides the polygons into smaller units which form small thaw-ponds. As wind and water erode the edges of the polygons, the lake enlarges, usually in a north-northwest to south-southeast direction. Eventually, small streams erode through the low edges and drain the lake. Ice wedges remain beneath the lakes and reassert after drainage, reinitiating the cycle. Vegetational changes are predictable and attuned to geomorphic changes. Mosses establish slowly in the first few years, followed by the grass, Dupontia fisheri, in the drier areas and Arctophila fulva in the wet places. Eriophorum angustifolium is characteristic throughout the terrestrial portion of the cycle. Carex aquatilis appears slowly and dominates the vegetation for per-

haps two or three thousand years, disappearing as ponds enlarge and Arctophila fulva reappears. Upon drainage, the vegetational cycle repeats. Man can seriously disrupt this delicate cyclic situation by artificially draining lakes and by allowing vehicles to damage the peat covering the ice wedges. The author postulates that increasing temperatures in the polar regions could accelerate the release of CO2 from the peat into the atmosphere, further increasing atmospheric CO2, eliminating the ice wedges, and inundating the coastal tundra. (Cassar-FRC)
W81-04791

**FROST HEAVE OF ROADS,**
Nottingham Univ. (England). Dept. of Civil Engineering.
R. H. Jones.
Quarterly Journal of Engineering Geology, Vol 13, No 2, p 77-86, 1980. 13 Fig, 47 Ref.

Descriptors: *Frost heaving, *Heaving, *Roads, Model studies, Aggregates, Design criteria, Road construction.

Three conditions are necessary for frost heave to occur beneath roads: zero isotherm sustained within the unbound materials, frost-susceptible materials, and an adequate supply of water at the freezing point. The Transport and Road Research Laboratory (TRRL) test, a semi-empirical method, judges a sample frost-susceptible if it heaves more than 13 mm (in England and Wales) or 18 mm (in Scotland) in 250 hours. This test freezes samples placed in cylinders 102 mm diameter x 152 mm high and measures heave. Other methods for assessing frost susceptibility involve suction characteristics and permeability characteristics. A rational method of design must involve (1) identification of the nature of damage (total heave, differential heave, thaw weakening), (2) selection of parameters to describe the damage, (3) assignment of limits to the parameters, (4) prediction of the value of the parameters in practical use, and (5) comparison of (3) and (4) to judge suitability of the design. An analytical method requires a quantitative theory of frost heave and development of a computer model, methods of measuring appropriate input parameters, and verification of model results in the laboratory and field. For this, the precise freezing cell offers promise for screening samples. At present, the semi-empirical method is most usable, with the development of an alternative method an ultimate goal. (Cassar-FRC)
W81-04855

**FOCUS ON POLAR RESEARCH,**
Washington Univ., Seattle. Dept. of Geological Sciences.
A. L. Washburn.
Science, Vol 209, No 4457, p 643-652, August, 1980. 2 Fig, 103 Ref.

Descriptors: *Polar regions, *Reviews, Atmosphere, Antarctic, Arctic, Cold regions, Water currents, *Ice, *Navigation, Arctic Ocean, Beaufort Sea.

Various scientific challenges confronting those engaged in polar research are described. Studies have been divided into groups for ease of discussion, these groups being the atmosphere, the hydrosphere, the cryosphere, the lithosphere, the biosphere, the peoples inhabiting the polar regions, and international aspects of such research. Research dealing directly with the atmosphere has centered around polar weather and its role in the world's weather machine, potential climatic changes, the variation of carbon dioxide in the atmosphere, influences of the upper atmosphere on the lower atmosphere, electrical coupling between the upper and lower atmospheres, and radio and other communications through the atmosphere. Hydrosphere research has been concerned with the currents in the Arctic Ocean, air-sea-ice interactions in the Beaufort Sea, acoustical characteristics of the Arctic water masses, studies of the Antarctic Circumpolar Current, living resources of the polar oceans, ways in which navigation in ice can be improved, and studies of water temperature near the bottoms of some lakes. These temperatures have been found to be as high as 25 C, indicating possible trapping of solar radiation beneath the ice cap, heating dense saline water, which remains on the bottom, storing the energy. (Baker-FRC)
W81-04992

## 2E. Streamflow and Runoff

**THREE-PARAMETER PROBABILITY DISTRIBUTIONS,**
Saint Johns River Water Management District, Palatka, FL.
D. V. Rao.
Journal of the Hydraulics Division, Proceedings of the American Society of Civil Engineers, Vol 107, No HY3, p 339-358, March, 1981. 1 Fig, 10 Tab, 10 Ref.

Descriptors: *Probability distribution, *Flood frequency, *Mathematical models, Frequency distribution, Floods, Hydrology, Low flow, Mathematical equations.

A comparative study of four well-known three-parameter probability distributions was undertaken to determine their usefulness as a base methods for flood flow frequency analysis. The distributions selected were lognormal, Weibull, Pearson type 3, and log Pearson type 3. Each three-parameter distribution was evaluated in a generalized fashion in terms of the dimensionless variate K (K = X/v sub in which X equals random variable and v sub n equals its mean), which has a population mean of unity. The bounds of the distributions, areas of the portions of distributions in the negative region of the variate when they enter such regions, and the differences in some important quantiles among the four distributions are presented. The four distributions become less applicable for hydrologic frequency analysis as they deviate more and more from their two-parameter counterparts. When they have well-applicable properties, their quantile values differ little for some or all distributions, indicating that choice of a distribution makes little difference. Some guidelines are provided for selecting the best applicable distribution for a given hydrologic sample. (Carroll-FRC)
W81-04769

**RETURN PERIOD FOR MEAN ANNUAL HYDROLOGIC EVENT,**
Saint Johns River Water Management District, Palatka, Florida. Water Resources Dept.
D. V. Rao.
Journal of the Hydraulics Division, Proceedings of the American Society of Civil Engineers, Vol 107, No HY3, p 366-369, March, 1981. 3 Tab, 1 Ref.

Descriptors: *Mathematical equations, *Hydrology, Floods, Flood recurrence interval.

Engineering hydrologists sometimes wish to assign a return period (T) to the mean annual hydrologic event. The value of the mean annual event is usually the arithmetic average (X) of annual series data, such as annual flood flows or annual low flows. The value of T is not a constant for this event X, but depends on the probability distribution assumed for the data sample. This paper presents T sub X values for some commonly used probability distributions in a generalized fashion. These values might be used for such purposes as setting flood insurance rates or determining how often an area might be inundated. (Carroll-FRC)
W81-04774

**DISTRIBUTION AND ABUNDANCE OF BENTHIC INVERTEBRATES IN A SONORAN DESERT STREAM,**
Arizona State Univ., Tempe. Dept. of Zoology.
D. A. Bruns, and W. L. Minckley.
Journal of Arid Environments, Vol 3, No 2, p 117-131, 1980. 4 Fig, 4 Tab, 54 Ref.

Descriptors: *Benthic fauna, *Deserts, *Natural streams, Stream biota, Invertebrates, Water analysis, Algae, Flooding, Light penetration, Aquatic life, Arizona, Sonoran Desert, Eutrophication, Aravaipa Creek.

Seasonal and longitudinal distributions of benthic invertebrates in Aravaipa Creek in the Sonoran Desert were investigated over a 13-month period to obtain some understanding of that desert aquatic system. Six sampling stations were set up above, within, and below the canyon. Samples were collected at six week intervals, and fauna was indentified with the keys of Usinger (1956) and Edmondson (1959). Physical and chemical data were collected, including dissolved oxygen, temperature, and pH. Benthic fauna populations fluctuated in response to current-substrate and incident light-filamentous algae interrelations, seasonal life-history phenomena, and the direct effects of floods. Increases were caused in some groups by input of particulate matter during flooding. A sand bottom supported a higher average density and biomass of invertebrates than did stony riffles. Distribution of invertebrates on the riffles was relatively uniform and was directly correlated with abundance of filamentous algae. The association of invertebrates and filamentous algae may indicate a major role of autochthonous organic material in trophic structure of the system. The largest numbers of early instars of aquatic insects were present in Aravaipa Creek when filamentous algae were at their peak. (Small-FRC)
W81-04837

**LONGITUDINAL DISPERSION IN RIVERS: THE PERSISTENCE OF SKEWNESS IN OBSERVED DATA,**
Geological Survey, Denver, CO.
C. F. Nordin, and B. M. Troutman.
Water Resources Research, Vol 16, No 1, p 123-128, February, 1980. 3 Fig, 3 Tab, 11 Ref.

Descriptors: *Rivers, *Diffusion coefficient, *Model studies, Mathematical studies, Streams, Dispersants.

A brief review of the theory and the theoretical values for the coefficient of skewness is given. This is followed by a comparison of some theoretical properties of the solution to the diffusion equation with observed properties of concentration-time curves from studies of three areas: the Wind-Bighorn river below Boysen Reservoir in Wyoming, Bear Creek near Morrison, Colorado, and the Missouri river. IRT is demonstrated that even where the Fickian diffusion equation is a good first approximation for predicting longitudinal dispersion processes, the observed data deviate consistently from the theory in that the skewness of the observed concentration distributions decreases much more slowly than the Fickian theory predicts. Finally it is demonstrated that inclusion of a dead zone term in the diffusion equation yields a theoretical skewness coefficient considerably larger than that given by the ordinary Fickian diffusion equation. This greater predicted skewness conforms more closely to the observed values, especially for large distances from the point of injection. However, even with the dead zone model, the skewness of the observed concentrations does not appear to be decreasing as rapidly as the theory predicts. (Baker-FRC)
W81-04920

**REASSESSMENT OF PLANT SUCCESSION ON SPOIL HEAPS ALONG THE BORO RIVER, OKAVANGO DELTA, BOTSWANA,**
Rhodes Univ., Grahamstown (South Africa). Dept. of Plant Sciences.
R. A. Lubke, G. L. Raynham, and P. E. Reavell.
South African Journal of Science, Vol 77, No 1, p 21-23, January, 1981. 3 Fig, 10 Ref.

Descriptors: *Vegetation regrowth, *Spoil banks, Vegetation, Plant growth, Dredging, *Boro River, *South Africa.

This study gives a new insight into the effect of dredging on the macrophytic vegetation of the Boro River. Eight transect sites were chosen at intervals along the lower reaches of the Boro, most coinciding with a bench marker. The transects were at right angles to the flow of the river and included major portions of the floodplain and both river banks. The dredging of the Boro has resulted in the creation of a deep canal in the center of the

river, the removal of its natural meanders and the deposition of spoil heaps along the river banks. This has increased water flow considerably and created a much more hostile environment for the natural succession of plant species. The deep channels cannot be readily colonized by submerged aquatics, nor can the steep banks be readily colonized. The primary colonizers of the spoil heaps are ruderal species with airborne seeds. The spoil was only sparsely covered with vegetation for the first year. Three species are common in the lower flood plain of the undisturbed river; these are the grasses Leersia hexandra and Oryza longistaminata and the sedge Schoenoplectus corymbosus. (Baker-FRC)
W81-04995

**THE VELOCITY OF THE RIVER TWEED AND ITS TRIBUTARIES,**
Edinburgh Univ. (Scotland). Dept. of Forestry and Natural Resources.
D. C. Ledger.
Freshwater Biology, Vol 11, No 1, p 1-10, 1981. 6 Fig, 6 Tab, 19 Ref.

Descriptors: *Flow velocity, *River flow, Velocity, Hydrometric stations, Scotland, *Tweed River, *Great Britain.

The River Tweed in Scotland is one of the few British rivers whose speed of flow is still essentially unaffected by human activity. The headwaters start as steep mountain torrents, later leveling off in the lowlands, where the gradient over the last 50 kilometers decreases to only 1 meter per kilometer. The channel width at Norham, which is the lowest gauged point, is about 100 meters. Velocity measurements were taken at 14 hydrometric stations in the Tweed basin over a 10 year period. Examination of the along-stream velocity variations showed that at most flow levels the highest velocities occur at the lower, flatter end of the river system. Estimates of the frequency with which velocities of different magnitudes can be expected to occur in the river were developed. These estimates indicate that the velocity at most stations rarely exceeds 3.0 meters per second, and for most of the time it lies between 0.25 and 1.0 meter per second. The discrepancy between the velocity measurements and the appearance of the river at various locations demonstrates the difficulties inherent in assessing relative velocity correctly by visual means alone. The study results suggest that it should not be difficult to produce reasonably reliable velocity information for almost any desired cross-section of the Tweed basin or other catchments with a reasonable hydrometric network. Only a small number of new observations should be required to derive relationships between velocity and discharge and acceptable estimates of the flow-frequency characteristics of new sites. (Carroll-FRC)
W81-04998

## 2F. Groundwater

**METHODS AND APPLICATIONS OF DIGITAL-MODEL SIMULATION OF THE RED RIVER ALLUVIAL AQUIFER, SHREVEPORT TO THE MOUTH OF THE BLACK RIVER, LOUISIANA,**
Geological Survey, Baton Rouge, LA. Water Resources Div.
A. H. Ludwig, and J. E. Terry.
Available from the National Technical Information Service, Springfield, VA 22161 as AD-A099 337, Price codes: A06 in paper copy, A01 in microfiche. Geological Survey Water-Resources Investigations 79-114, May, 1980. 103 p, 29 Fig, 13 Tab, 22 Ref.

Descriptors: *Groundwater, *Model studies, *Alluvial aquifers, Aquifer characteristics, Groundwater movement, Computer programs, *Louisiana, Red River Valley.

The Red River Waterways Project provides for the construction of five locks and dams on the Red River from the Mississippi River to Shreveport, La. The methodology used by the U.S. Geological Survey in studying the effects of the navigation pools on the ground-water-flow regime involved digital modeling of steady- and nonsteady-state conditions. The steady-state model, GWFLOW, computes the head response in an aquifer due to various boundary conditions. The nonsteady-state model, SUPERMOCK, was designed to simulate transient stress and response in an alluvial-flow system. In addition to the simulation models several computer programs were developed during the study to aid in the preparation of field data for input to the models and in the calibration of the models. Calibration techniques unique to each of the models were developed for the investigation. (USGS)
W81-04665

**GROUND-WATER LEVELS IN SELECTED WELL FIELDS AND IN WEST-CENTRAL FLORIDA, SEPTEMBER 1979,**
Geological Survey, Tampa, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W81-04666

**POTENTIOMETRIC SURFACE OF THE FLORIDAN AQUIFER, SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT, SEPTEMBER 1979,**
Geological Survey, Tampa, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W81-04667

**WATER TABLE IN THE SURFICIAL AQUIFER AND POTENTIOMETRIC SURFACE OF THE FLORIDAN AQUIFER IN SELECTED WELL FIELDS, WEST-CENTRAL FLORIDA, MAY 1979,**
Geological Survey, Tampa, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W81-04668

**GROUND WATER IN THE SPRINGFIELD-SALEM PLATEAUS OF SOUTHERN MISSOURI AND NORTHERN ARKANSAS,**
Geological Survey, Rolla, MO. Water Resources Div.
E. J. Harvey.
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-205635, Price codes: A04 in paper copy, A01 in microfiche. Geological Survey Water-Resources Investigations 80-101, December, 1980. 66 p, 25 Fig, 6 Tab, 38 Ref.

Descriptors: *Groundwater, *Aquifers, *Aquifer characteristics, *Karst, Geology, Groundwater recharge, Water level, Groundwater movement, Wells, Surface-groundwater relations, Water use, Water quality, Water pollution sources, Water analysis, *Missouri, *Arkansas, Springfield Plateau, Salem Plateau.

Average ground-water conditions have not changed significantly in the Springfield-Salem plateaus section of southern Missouri and northern Arkansas in the past 25 years except in the vicinity of well fields. The amount of ground water pumped is approximately 200 cubic feet per second, which is about 5 percent of the total discharge at the 80 percent point on flow-duration curves for major streams. Ground-water recharge is variable and occurs through sinkholes by infiltration in upland areas of good permeability, and through streambeds that lose flow. Main water-bearing zones lie in the Potosi Dolomite and the lower dolomite and sandstone of the Gasconade Dolomite. Cavernous connections from ground surface to depths as great as 1,500 feet occur in the West Plains area, Mo., and result in deep circulation of water. Municipal well-water in the area often becomes turbid after rainstorms, despite well depths of 1,500 feet and 950 to 1,000 feet of pressure-grouted casing. Ground-water movement is generaly north and south from the crest of the Springfield-Salem plateaus, which extend across southern Missouri from the St. Francois Mountains to the southwest. Interbasin diversion of surface- and ground-water flow is common. (USGS)
W81-04669

**WATER BUDGET AND MATHEMATICAL MODEL OF THE COCONINO AQUIFER, SOUTHERN NAVAJO COUNTY, ARIZONA,**
Geological Survey, Tucson, AZ. Water Resources Div.
L. J. Mann.
Geological Survey Open-File Report 79-348, January, 1979. 58 p, 11 Fig, 4 Tab, 16 Ref.

Descriptors: *Groundwater, *Hydrologic budget, *Mathematical models, Aquifer characteristics, Hydraulic conductivity, Base flow, Evapotranspiration, *Arizona, Navajo County.

The main source of water in the 3,400-square-mile area of southern Navajo County, Ariz., is the large volume in storage in the Coconino aquifer. Withdrawals from the aquifer increased from about 13,800 acre-feet in 1960 to 38,400 acre-feet in 1972. Aquifer tests indicate that hydraulic conductivity ranges from 8 to 40 feet per day; the flow-net analysis indicates that the hydraulic conductivity may be as much as 80 feet per day in places. In the southern and central parts the aquifer is unconfined, and the storage coefficient is estimated to be about 0.15. In the northern and eastern parts the aquifer is confined, and the storage coefficient ranges from 0.00013 to 0.0014. A mathematical model was developed to simulate the groundwater system and to provide a management tool for estimating the effects of pumping. The model indicates that the inflow to and outflow from the aquifer were about 105,600 acre-feet in 1960 and that about 192,000 acre-feet of water was derived from storage in 1960-72. The model provides an approximation of the Coconino aquifer. (USGS)
W81-04672

**OPTIMAL ENERGY EXTRACTION FROM A HOT WATER GEOTHERMAL RESERVOIR,**
Woodward Clyde Consultants, San Francisco, CA.
For primary bibliographic entry see Field 1A.
W81-04913

**A METHOD FOR DETERMINING THE HYDRAULIC PROPERTIES OF TIGHT FORMATIONS,**
Geological Survey, Reston, VA.
J. D. Bredehoeft, and S. S. Papadopulos.
Water Resources Research, Vol 16, No 1, p 233-238, February, 1980. 4 Fig, 2 Tab, 4 Ref.

Descriptors: *Hydraulic properties, *Permeability, Hydrology, Fluid mechanics, Hydraulic permeability, Ground water movement, *Aquifers.

An alternative method for evaluating tight formations of very low permeability is presented. The method is to be used in cases where the field test can be conducted within a relatively short period of time. The method is essentially a modification of the conventional slug test. Instead of causing an instantaneous water level change and observing its decay in an open standpipe, the well is filled with water to the surface and suddenly pressurized with an additional amount of water. The well is then shut-in and the decay of pressure, or of the additional head change caused by the pressurization, is noted. Type curves prepared from this solution are matched with observed data to determine the hydraulic properties of the formation tested. (Baker-FRC)
W81-04919

**PIEZOMETRIC DETERMINATION OF INHOMOGENEOUS HYDRAULIC CONDUCTIVITY,**
Israel Inst. of Tech., Haifa. Dept. of Civil Engineering.
S. Irmay.
Water Resources Research, Vol 16, No 4, p 691-694, August, 1980. 14 Ref.

Descriptors: *Hydraulic conductivity, *Porous media, *Piezometric head, Anisotropy, Heat transfer, Aquifers, Groundwater flow, Measuring instruments.

The hydraulic conductivity of inhomogeneous, isotropic, or anisotropic saturated stable porous media is computed from the observed or known field of the piezometric head in both Cartesian and curvilinear orthogonal coordinates. This is applied to the general case and to some special forms of piezometric head. The method can be applied to aquifer flow and to heat transfer, but not to unsteady state flow. The accuracy depends on the proper choice of piezometric head and on several derivatives. (Cassar-FRC)
W81-04922

**EVALUATING GROUNDWATER SUPPLY IN NEW PROJECT AREAS WITH SPCIAL REFERENCE TO DEVELOPING COUNTRIES,**
International Rice Research Inst., Los Banos (Philippines). Dept. of Irrigation and Water Management.
B. M. Sahni.
Water Supply and Management, Vol 5, No 2, p 151-164, 1981. 8 Fig, 2 Tab, 22 Ref.

Descriptors: *Test wells, *Well data, *Well hydarulics, Aquifer testing, *Groundwater availability, Well yield, Groundwater management, *Developing countries, Groundwater development.

The utility of test data obtained from an abstraction well is examined in evaluating hydraulic characteristics of the aquifer. Usually, observation wells are drilled and pumping data are analyzed, but time and cost constraints can prohibit test well drilling. Aquifer tests run in the abstraction well can provide reasonable estimates of aquifer properties and groundwater recovery potential. If the effective radius of a pumped well, the turbulence exponent, and the head loss coefficients are known, it isjpossible to calculate the storage coefficient from Thesi' non-equilibrium equation using APT data obtained from the pumped well. One can also predict the drawdown for any given discharge. This information is also used to determine the most appropriate depth of the pump bowl and optimum drawdown or discharge for a given well. These hydraulic parameters can be used in designing well fields for development of grondwater resources of the area, estimating the effects of pumping at a given rate on the yields of other wells, calculating safe yields, controlling salt water intrusion, andother problems. (Small-FRC)
W81-04969

**THE USE OF A NUMERICAL MOEL IN THE MANAGEMENT OF THE CHALK AQUIFER IN THE UPPER THAMES BASIN,**
Institute of Hydrology, Wallingford (England).
E. H. Morel.
Quarterly Journal of Engineering Geology, Vol 13, No 3, p 153-165, 1980. 9 Fig, 36 Ref.

Descriptors: *Aquifer management, *Groundwater development, Model studies, *Thames River Basin, Upper Thames Basin, Chalk aquifer, Drought, Streamflow, Boreholes, Drawdown, Water resources development, United Kingdom.

A numerical model was constructed to represent groundwater flow in the Chalk aquifer in the Upper Thames Basin. Aquifer performance was evaluated for the period of the severe drought of 1975-76 when river flow was augmented ty pumping groundwater into the rivers. The main loss of water was caused by stream-bed leakage and evaporation from the riparian zone. Model results agreed satisfactorily with observed groundwater lvels and river flows. Errors occurred during winter recharge periods, probably from inadequate representation of the soil moisture extraction process. During drought conditions errors are expected to be small. The moel was used to estimate the behavior of the Chalk aquifer if further water is pumped for river augmentaion during drought conditions. Guidelines were formulated for future aquifer development, which should be concentrated on the outcrop rather than the confined area and use a dense network of production boreholes (450 mm diameter) in the middle andloer slopes of the valleys. According to this approach, the Chalk in the Upper Thames Basin could yield 300,000 cu meters per fay during severe droughts. (Cassar-FRC)
W81-04970

**FAULT CONTROL OF GROUNDWATER FLOW AND HYDROCHEMISTRY IN THE AQUIFER SYSTEM OF THE CASTLECOMER PLATEAU, IRELAND,**
Geological Survey of Ireland, Dublin.
D. Daly, J. W. Lloyd, B. D. R. Misstear, and E. D. Daly.
Quarterly Journal of Engineering Geology, Vol 13, No 3, p 167-175, 1980. 7 Fig, 2 Tab, 4 Ref.

Descriptors: *Geologic faults, *Groundwater flow, *Aquifer evaluation, Geohydrology, Aquifer characteristics, Chemical properties, Salinity, Castlecomer Plateau, *Ireland.

The Castlecomer Plateau consists of two main aquifers, Clay Gall Sandstone and Swan Sandstone. Major faulting has produced three major structural blocks with very little hydraulic conductivity between blocks. Strata throughout the blocks are displaced, and hydraulic conductivity is very complex. Chemical analysis of waters from 19 wells indicates areas of restricted flow. The two major hydrochemical processes are carbonate dissolution and ion exchange (increases in Na and decreases in Ca and Mg). Since these processes occur progressively with groundwater flow and salinity, the degree of chemical change may be considered a function of residence time in the aquifer and of the control of the faults over groundwater flow. (Cassar-FRC)
W81-04993

## 2G. Water In Soils

**SPATIAL AND TEMPORAL PATTERNS OF INFILTRATION,**
Dundee Univ. (Scotland). Dept. of Geography.
A. S. Tricker.
Journal of Hydrology, Vol 49, No 3/4, p 261-277, February, 1981. 5 Fig, 4 Tab, 19 Ref.

Descriptors: *Infiltration, *Soil water, Hydrology, Rainfall infiltration, Clays, Spatial distribution, Temporal distribution, Soil horizons, Soil profiles, Seasonal variation, Netherlands.

The control of spatial and temporal variations of infiltration rates was investigated within the geographical framework of a small stream catchment. The first part of the study concentrates on a reconnaissance survey of the spatial patterns of infiltration within a small catchment and the factors that influence the process in a spatial context. Considerable spatial contrasts were recorded at 23 sites, and statistical analysis of the data demonstrated that soil horizon dimensions exert the greatest control on infiltration. During the second part of the study a smaller number of selected sites within the catchment were examined over the period of one year to determine possible seasonal changes. Strong seasonal patterns of infiltration rates, closely related to soil moisture changes, are recorded at some sites, whereas another site shows only slight relationships with other temporally-variable factors. Regression analytical techniques were used to attempt to isolate the dominant influencing factors. (Baker-FRC)
W81-04804

**PERMEABILITY OF THREE COMPACTED TROPICAL SOILS,**
Benin Univ. (Nigeria).
S. A. Ola.
Quartely Journal of Engineering Geology, Vol 13, No 2, p 87-95, 1980. 1 Fig, 1 Tab, 13 Ref.

Descriptors: *Permeability, *Soil structure, *Soil compaction, Clays, Physical properties, Soil physical properties, Compaction, Structure, Saturation, Soil moisture.

Permeability of three widely differing tropical Nigerian soils was studied as a function of degree of saturation, compactive efforts, and thixotropic strength ratios. Sokoto soft clay shale (attapulgite) was most structure sensitive, followed by Maiduguri black cotton soil (montmorillonite and kaolinite), and A-7-6 lateritic soil (kaolinite), the least structure sensitive. Complete saturation of most compacted soils required a back pressure of 8 kg per sq cm. Although the jpermeability behavior of compacted soils was predictable, it varied from clay to clay. Molding moisture content must be considered in determining the permeability and mermeability ratio of the soils. Aging increased strength. Samples tested 28 days after compaction had higher permeability than freshly compacted samples. Thixotropic strength ratios in the three soils at optimum moisture content increased by 1.5 over 28 days. The relationship between permeability and the cube of degree of saturation was linear, with the slopes depending on structure and mineraloy of each soil. (Cassar-FRC)
W81-04973

## 2H. Lakes

**DATA ON SELECTED LAKES IN WASHINGTON, PART 6,**
Geological Survey, Tacoma, WA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W81-04673

**LIMNOLOGICAL CONDITIONS IN SOUTHERN LAKE HURON, 1974 AND 1975,**
Michigan Univ., Ann Arbor. Great Lakes Research Div.
C. L. Schelske, R. A. Moll, and M. S. Simmons.
Available from the National Technical Information Service, Springfield, VA 22161 as PB80-226004, Price codes: A09 in paper copy, A01 in microfiche. Environmental Protection Agency Report EPA-600/3-80-074, July, 1980. 188 p, 54 Fig, 34 Tab, 95 Ref.

Descriptors: *Water quality, *Pigments, *Phytoplankton, *Primary productivity, *Nutrients, Limnology, Thermocline, Seasonal variation, Enrichment, Saginaw Bay(Michigan), Limiting nutrients, Nearshore processes, *Lake Huron.

In 1974 and 1975, several studies were conducted on southern Lake Huron and outer Saginaw Bay to obtain seasonal data on limnological conditions. In 1974, 44 stations were sampled on each of eight cruises conducted from April to November. Each station was sampled at multiple depths so that more than 200 samples were taken on each cruise. Data obtained for each sample included water temperature, pH, specific conductance, chloride, total phosphorus, soluble reactive silica, nitrate plus nitrite nitrogen, ammonia nitrogen, chlorophyll a, and phaeopigments. In 1975, five special cruises were conducted. Four of these were used to compare phytoplankton productivity and nutrient dynamics in the frontal zone between highly enriched Saginaw Bay and the relatively low productivity waters of southern Lake Huron. One cruise was used to study the effect of the spring thermal bar on the distribution of nutrients and nearshore phytoplankton standing crops. These studies confirm that Saginaw Bay and the nearshore zone of southern Lake Huron have larger concentrations of total phosphorus (the major growth limiting nutrient in the system) and greater standing crops of phytoplankton than the offshore waters. They also show that the nearshore zones, especially on the Canadian shore, differ from the offshore waters to a greater degree during the period of the spring thermal bar than at other times of the year.
W81-04693

**PHYTOPLANKTON COMPOSITION AND ABUNDANCE IN SOUTHERN LAKE HURON,**
Michigan Univ., Ann Arbor. Great Lakes Research Div.
For primary bibliographic entry see Field 5C.
W81-04697

**MATHEMATICAL MODELS OF WATER QUALITY IN LARGE LAKES, PART 1: LAKE HURON AND SAGINAW BAY,**
Manhattan Coll., Bronx, NY. Environmental Engineering and Science Program.
D. M. DiToro, and W. F. Matystik, Jr.
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-114217, Price codes: A09 in paper copy, A01 in microfiche. Environmental Protection Agency Report EPA-600/3-80-056, July, 1980. 180 p, 69 Fig, 30 Fig, 105 Ref, Append.

Descriptors: *Water quality, *Mathematical models, *Lakes, *Eutrophication, *Phytoplankton, *Phosphorus, Water quality management, Effluents, Nutrients, Zooplankton, Phosphorus removal, Biomass, Municipal wastes, *Lake Huron, *Saginaw Bay.

This research was undertaken to develop and apply a mathematical model of the water quality in large lakes, particularly Lake Huron and Saginaw Bay (Part 1) and Lake Erie (Part 2), in order to provide a framework for assessing, managing, and controlling eutrophication problems in these lakes. A mathematical model of phytoplankton biomass was developed which incorporates both phytoplankton and zooplankton as well as phosphorus, nitrogen and silica nutrient forms. Extensive water quality data for Lake Huron and Saginaw Bay were analyzed and statistically reduced. The model was then calibrated by comparison of computed results to these data. An exhaustive treatment of the kinetics employed for modeling the eutrophication process is presented. The sensitivity of the model to some of its key parameters is examined. In addition, responses of water quality in Lake Huron and Saginaw Bay system to variations in total phosphorus inputs are projected. Phosphorus reductions at municipal sewage treatment plants in the Saginaw Bay area to effluent concentrations of 1mg/l, which will reduce the Saginaw Bay load by 600 tonnes/yr, will result in yearly average chlorophyll concentrations of about 1.1 microgram/l in Southern Lake Huron and 10.7 microgram/l in Saginaw Bay. (Brambley-SRC)
W81-04725

**MATHEMATICAL MODELS OF WATER QUALITY IN LARGE LAKES, PART 2: LAKE ERIE,**
Manhattan Coll., Bronx, NY. Environmental Engineering and Science Div.
D. M. DiToro, and J. P. Connolly.
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-110967, Price codes: A11 in paper copy, A01 in microfiche. Environmental Protection Agency Report EPA-600/3-80-065, July, 1980. 248 p, 92 Fig, 48 Tab, 85 Ref, Append.

Descriptors: *Water quality, *Mathematical models, *Lakes, *Nutrients, *Phytoplankton, *Oxygen depletion, Phosphorus, Nitrogen, Oxygen demand, Phosphorus removal, Eutrophication, Diatoms, Zooplankton, Geochemistry, Effluents, Water quality control, *Lake Erie.

This research was undertaken to develop and apply a mahematical model of the water quality in large lakes, particularly Lake Huron and Saginaw Bay (Part 1) and Lake Erie (Part 2). A mathematical model was developed for analysis of the interactions between nutrient discharges (primarily phosphorus and nitrogen) to Lake Erie, the response of phytoplankton to these discharges, and the dissolved oxygen depletion that occurs as a consequence. Dissolved oxygen, phytoplankton chlorophyll for diatoms and nondiatoms, zooplankton biomass, nutrient concentrations in available and unavailable forms and inorganic carbon are considered in the model. Extensive water quality data for Lake Erie were analyzed and statistically reduced. Comparison of data from 1970 and 1973-74 to model calculations served for calibration of the model. A verification computation was also performed for 1975, a year when no anoxia was observed. Recent developments in phytoplankton growth and uptake kinetics are included in this analysis. The methods of sedimentary geochemistry are expanded to include an analysis of sediment oxygen demand within the framework of mass balances. Projected effects of varying degrees of phosphorus removal on dissolved oxygen, anoxic area, chlorophyll, transparency and phosphorus concentration are presented. (Author's abstract)
W81-04726

**MAJOR PROBLEMS OF LAKE WATER QUALITY IN ILLINOIS,**
Illinois Environmental Protection Agency, Springfield. Div. of Water Pollution Control.
M. Meyer.
In: Proceedings of a Round Table on Reclaiming and Managing Lakes in Illinois, October 10-11, 1980. Illinois Institute of Natural Resources, Chicago, Document No 81/06, February, 1981. p4-9, 3 Tab, 2 Ref, Append.

Descriptors: *Illinois, *Artificial lakes, *Water quality control, *Water quality standards, Retention time, Storage ratio, Water depth, Opacity, Suspended solids, Phosphorus compounds, Turbidity, Chlorophyll a, Tropic level.

Sediment pollution (suspended inorganic material and deposition of sediment) is the most serious problem of Illinois lakes. The water quality, use impairment, and characteristics of these lakes are influenced by origin, location, morphology, hydrology, watershed characteristics, and meteorological conditions. This report discusses six artificial impoundments in Central Illinois that were part of the Illinois Environmental Protection Agency's (IEPA) 1979 lake sampling program. The six lakes, Otter, Lincoln Trail, Pittsfield, Mattoon, Paradise, and Taylorville are ranked for expected water quality based on mean depth, watershed equivalent inches, retention time, and drainage area to storage capacity ratio. To assess water quality, Carlson's Trophic State Index (TSI) is applied to Secchi transparency, chlorophyll a, and total phosphorus data. Total suspended solids (TSS) and nonvolatile suspended solids (NVSS) are also included. Otter Lake has the best physical characteristics; however, the August 1979 TSI average values show Lincoln Trail with the best water quality, probably as a result of its higher percentage of cropland to woodland. Lake Taylorville ranks fourth on the list because the TSI value for chlorophyll is low---a result of high turbidity and a short retention time. Better water quality is related to long retention time, low watershed area to lake capacity ratio, and greater mean depth, as well as little urbanization, less row crop cultivation, and soils with low fertility and erosivity. As these characteristics become less desirable water quality tends to decline. (Atkins-Omniplan)
W81-04728

**AN OVERVIEW OF IN-LAKE TREATMENT TECHNIQUES FOR WATER QUALITY MANAGEMENT,**
Illinois State Water Survey, Peoria. Water Quality Section.
V. Kothandaraman.
In: Proceedings of a Round Table on Reclaiming and Managing Lakes in Illinois, October 10-11, 1980. Illinois Institute of Natural Resources, Chicago, Document No 81/06, February, 1981, p 27-42. 20 Ref.

Descriptors: *Lake restoration, *Rehabilitation, *Lake sediments, *Eutrophic lakes, *Nutrient removal, Eutrophication, Chemical treatment, Copper sulfate, Destratification, Dredging, Aeration, Biological treatment.

Within the past decade, there has been a significant resurgence in the U.S. of efforts to protect, rehabilitate, and restore lakes and impoundments--a valuable and important segment of the nation's water resources. Measures which may be effective in restoring and enhancing the quality of lakes fall into two major categories: limiting nutrient influx by controlling point and non-point nutrient sources and by nutrient diversion; and in-lake treatment and control measures. This report outlines the advantages and disadvantages of each of nine in-lake treatment and control measures: dredging, nutrient inactivation/precipitation, dilution and dispersion, lake bottom sealing, artificial destratification and hypolimnetic aeration, sediment exposure and desiccation, nuisance organism harvesting, chemical control of nuisance organisms, and biological control of nuisance organisms. The report concludes that of the nine methods, chemical treatment has the greatest utility and justification in highly eutrophic lakes in which the nutrient supply cannot be effectively controlled, or in which nutrient control measures are envisaged for the future. The toxicity to humans of copper sulfate presents no problem at the concentration levels normally used in lakes and reservoirs. Biological controls have had only limited success. However, the report also points out that in any lake restoration program, the initial step, and the only step that leads to permanent improvement, is to control the input of undesirable materials. (Garrison-Omniplan)
W81-04729

**IN-LAKE CONTROL OF NUISANCE VEGETATION: A REVIEW OF EIGHT PROCEDURES,**
Kent State Univ., OH. Dept. of Biological Sciences.
For primary bibliographic entry see Field 5G.
W81-04730

**DREDGING IN ILLINOIS,**
Illinois State Water Survey, Urbana.
W. J. Roberts.
In: Proceedings of a Round Table on Reclaiming and Managing Lakes in Illinois, October 10-11, 1980. Illinois Institute of Natural Resources, Chicago, Document No 81/06, February, 1981, p 56-59.

Descriptors: *Dredging, *Reservoirs, *Lake restoration, *Sediments control, *Water storage, Lake sediments, Water supply, Bottom sediments, Erosion, Storage requirements, Water quality, Storage reservoirs, *Illinois.

Loss of storage is one of the greatest problems facing most Illinois water supply lakes. High rates of sedimentation have greatly shortened the useful lives of many such impoundments. This brief overview of Illinois dredging operations includes descriptions of the small portable dredges developed over the past 15 years that have made it possible to remove sediment hydraulically from small lakes. Two main types of dredges--the cutterhead and the horizontal auger--have been used successfully in Illinois. A cutterhead used in Lake Carlinville resulted in a removal cost per yard of about $1.80. A successful dredging operation in Oakland in Coles County used a horizontal auger-type dredge to remove 95,198 cubic yards of sediment at an overall cost of $0.76 per yard. Descriptions of two operations in smaller residential lakes are included as examples of strengths and weaknesses of dredging as a permanent solution to sedimentation: one near Mahomet was dredged and will need to be dredged again in 15 years; one south of Champaign was drained, the dry lake bed was removed by trucks, and a sedimentation pond was added. This lake will probably experience a long life, since all flood flows will be routed around the lake and the upstream pond will collect most of the sediment. In contrast, the lake near Mahomet has about 100,000 cubic yards of sediment entering the lake each year, resulting in a high annual loss of storage of 3.4 percent. (Garrison-Omniplan)
W81-04731

**LAKE LANSING RESTORATION--ITS GOALS, SUCCESSES AND DISAPPOINTMENTS,**
Ingham County Dept. of Public Works and Drain Commission, Lansing, MI.
R. L. Sode.
In: Proceedings of a Round Table on Reclaiming and Managing Lakes in Illinois, October 10-11, 1980. Illinois Institute of Natural Resources, Chicago, Document No 81/06, February, 1981. p64-76, 3 Append.

Descriptors: *Lake restoration, *Bottom sediments, *Eutrophication, *Project planning, *Eutrophic lakes, Projections, Lake sediments, Dredge spoil, Sediment control, Economic aspects, Costs, Scheduling, Lake shores, Lansing Lake.

The primary goal of this project is to restore the recreational potential of Lake Lansing using envi-

ronmentally sound and economically feasible techniques. The proposal to remove excessive weed growth from this intermediate-sized, eutrophic lake involves dredging 1.6 million cubic yards of bottom sediment. The project includes shoreline improvements that re-distribute sand from shallow sandy areas to those without sand. The project encountered some unanticipated hydrogeological, legal, and engineering problems that increased costs from $2.5 million to $3.8 million. Hydrogeological problems included relocation of all spoil disposal sites from primarily wetland areas to all upland sites, failure of a dike, and increased frequency of groundwater sampling. State statutes permitting legal intervention by citizens resulted in delays because of legal action regarding jurisdictional questions. Engineering problems included the need for lake level augmentation wells, the design and construction of a lowhead and mitigative ponds, and the design and construction of a toe drain. Processes underway include surface water monitoring, groundwater monitoring, and pre- and post-dredging monitoring. (Garrison-Omniplan)
W81-04733

**BIOLOGICAL ASPECTS OF EUTROPHICATION,**
Illinois Univ. at Urbana-Champaign.
M. Lynch.
In: Proceedings of a Round Table on Reclaiming and Managing Lakes in Illinois, October 10-11, 1980. Illinois Institute of Natural Resources, Chicago, Document No 81/06, February, 1981, p 81-86. 14 Ref.

Descriptors: *Lake restoration, *Biocontrol, *Algal growth, *Water quality control, *Eutrophic lakes, Ecosystems, Benthic flora, Fish diets, Iced lakes, Fish populations, Fish stocking, Algae, Eutrophication.

Attempts to reduce the growth of nuisance bluegreen algae generally are those which (1) reduce the influx of nutrients to lakes, and (2) eradicate algal blooms by chemical or mechanical means. The relationship between summer phosphorus and chlorophyll is often interpreted to mean that the greenness of lakes is connected to phosphorus; however, some lakes with high phosphorus concentration nonetheless have very low standing crops of algae. Fish have an important influence on the response of lakes to nutrients; the number and species of fish in a lake determine its sensitivity to nutrient enrichment. Even if all external sources of nutrients were eliminated from a lake, the internal loading of nutrients resulting from a dense population of benthic feeding fish could be sufficient to support considerable algal growth. By selectively removing the large herbivorous zooplankton from lakes, these fish cause dramatic changes in both the total abundance and the composition of the phytoplankton community. Lakes that lose their fish populations as a consequence of anoxic conditions under ice cover often show a dramatic increase in transparency the following spring. The most obvious approach to the undesirable consequency of enrichment is to encourage the growth of populations of large Daphnia. For example, Lake Tahoe, an oligotrophic lake, is now in a precarious position because in 1970 the Daphnia disappeared, causing the lake to be maximally sensitive to any increased nutrient loading. One means is to restructure a fish community by heavy stocking with larger, predatory fish. (Garrison-Omniplan)
W81-04735

**CHEMICAL CHARACTERISTICS OF LAKE SEDIMENTS,**
Illinois State Water Survey, Urbana. Aquatic Chemistry Section.
M. J. Barcelona.
In: Proceedings of a Round Table on Reclaiming and Managing Lakes in Illinois, October 10-11, 1980. Illinois Institute of Natural Resources, Chicago, Document No 81/06, February, 1981, p 10-20. 11 Fig.

Descriptors: *Lakes, *Chemical composition, *Sediment, *Oxygen, *Carbon, Sediment-water interfaces, Suspended solids, Aquatic soils, Oxygen depletion, Dissolved solids, Anaerobic conditions, Aerobic conditions, Organic compounds, Mineralization, Cycling nutrients.

Lake sediments can pose problems even when a reservoir's storage capacity is not threatened by their accumulation. Dead and decaying materials sink and accumulate in the sediment column. Microorganisms in the sediment continue to remineralize organic forms of carbon, nitrogen, phosphorus and sulfur back into inorganic forms such as CO2, NH3, PO4, and SO4. The sediment system parallels industrial waste treatment processes in that the product of the treatment is subject to the availability of dissolved oxygen. When oxygen is depleted, anaerobic processes begin and the products are reduced forms of iron and manganese, methane, ammonia, phosphate, sulfides, and organosulfur. Sediment particles are a mixture of soil and aquatic biological solids with some aerosol particles. The particles are both inorganic and organic and likely have microbial components on their surfaces. Once the particles accumulate as sediment, the microbial population mediates many chemical interactions. Some nutrient recycling occurs in the water and involves: the uptake of inorganic forms of carbon, nitrogen, phosphorus and silicon, the transformation to organic and skeletal forms of the elements, and finally the remineralization of the elements. Oxygen availability is important to the complete remineralization of organic matter. Lake Paradise, Mattoon is used as an example of sediment processes on carbon recycling. Some conclusions drawn are that compounds associated with carbon are products of microbial activity and that sediments can act as a source of dissolved oxygen matter to the water. Also, physical factors play a prominent role in chemical characteristics of lake sediments. (Atkins-Omniplan)
W81-04751

**PREDICTION OF LOCAL DESTRATIFICATION OF LAKES,**
Oklahoma State Univ., Stillwater. School of Mechanical and Aerospace Engineering.
A. A. Busnaina, D. G. Lilley, and P. M. Moretti.
Journal of the Hydraulics Division, Proceedings of the American Society of Civil Engineers, Vol 107, No HY3, p 259-272, March, 1981. 11 Fig, 13 Ref.

Descriptors: *Simulation, *Destratification, *Reservoirs, Mixing, Mathematical models, Prediction, Thermal stratification, Flow pattern, Design criteria, Hydrodynamics, Lakes, Hydraulics, Computer models.

Thermal stratification may occur in water reservoirs during the hot months of summer, presenting a serious problem for reservoirs with low-level release structures in that the quality of water released may be poor, since most of the exit flow comes from the bottom layer of water in the reservoir. There has been a continued interest in local mechanical destratification of reservoirs to improve water quality. A low-energy axial flow propeller may be positioned just below the water surface to provide a downward directed jet of water and thereby locally mix the reservoir in the vicinity of the release structure of the dam. This paper presents a numerical simulation of the flow field of the jet induced by an axial flow propeller pump performed by solving the governing equations of the flow field. The two-dimensional Los Alamos SOLA prediction technique has been expanded to include diffusion as well as buoyancy forces in an axisymmetric stratified flow field. Comparison with hydraulic models shows that this numerical simulation of the local destratification phenomenon is useful for the prediction of jet penetration depth or of the dilution factor (released water quality). The main dynamic effects are modeled adequately to show the same trends as the available physical data. The prediction procedure represents a low-cost basic tool to show the influence of design parameters on the flow field. An empirical expression for prediction of the penetration depth is suggested on the basis of experimental and computational results. (Carroll-FRC)
W81-04764

**NUMERICAL CIRCULATION MODEL FOR WIND INDUCED FLOW,**
Maine Univ. at Orono. Dept. of Civil Engineering.
B. R. Pearce, and C. K. Cooper.
Journal of the Hydraulics Division, Proceedings of the American Society of Civil Engineers, Vol 107, No HY3, p 285-302, March, 1981. 2 Fig, 33 Ref.

Descriptors: *Flow characteristics, *Channel flow, *Wind-driven currents, Lakes, Water currents, Eddies, Water depth, Surface water, Mathematical models, Wind.

Based on a compilation of current data at the surface, it is concluded that the classical Ekman theory is not appropriate for calculating wind-generated currents near the surface of a sea or lake. The cause is found to be the assumption by Ekman of a vertical eddy viscosity, N sub v, which is constant over a depth. A numerical model is described briefly which allows for a variation of N sub v over depth, z, as well as in the x and y directions. The model was developed using a Galerkin technique which is expanded so that the model can include a sharp, wind-driven profile near the surface. The method is computationally reasonable, requiring about the same number of computations as a vertically averaged formulation. Simple stability criteria are presented. In order to test coding and accuracy, the model is compared to several analytic test cases. A relationship for choosing N sub v is presented. Comparison of experimental data to the numerical model results indicated good correlation. (Carroll-FRC)
W81-04766

**VEGETATIONAL CHANGE AND ICE-WEDGE POLYGONS THROUGH THE THAW-LAKE CYCLE IN ARCTIC ALASKA,**
Duke Univ., Durham, NC. Dept. of Botany.
For primary bibliographic entry see Field 2C.
W81-04791

**THE APPLICATION OF THE BIOCENOTIC MODEL FOR THE PREDICTION OF THE EFFECTS OF AN IMPOUNDMENT OF FLOWING WATER,**
Baden-Wurttemberg Landesanstalt fuer Umweltschutz (Germany, F.R.).
For primary bibliographic entry see Field 6G.
W81-04812

**MORE COMPLICATIONS IN THE CHLOROPHYLL-SECCHI DISK RELATIONSHIP,**
Kent State Univ., OH. Dept. of Biological Science.
R. E. Carlson.
Limnology and Oceanography, Vol 25, No 2, p 379-382, March, 1980. 2 Fig, 1 Tab, 13 Ref.

Descriptors: *Chlorophyll, *Secchi disks, *Bioindicators, Mathematical equations, Limnology, Algae, Biomass, Indicators, Lakes, Transparency, Phosphorus, Trophic level, Light quality, Correlation analysis, Productivity, Aquatic productivity.

Possible explanations for the nonlinear relationship between the inverse of transparency and chlorophyll content in lakes are suggested. Although equations using Secchi disk transparency data and other biomass indicators predict a linear relationship, experimental results reveal non-linear curves. Data from five Minnesota lakes is presented which suggests that chlorophyll is linearly related to biomass and that the Secchi index distorts changes in algal biomass. One possible explanation, random variation, does not account for the nonlinear data presented. Other explanations are that the total phosphorous-chlorophyll relationship is also nonlinear, or that chlorophyll is nonlinearly related to seston dry weight and to total particle volume. These all suggest that the problem of nonlinearity involves chlorophyll rather than other biomass variables. (Titus-FRC)
W81-04825

**PHOTOSYNTHETIC BACTERIAL PRODUCTION IN LAKES: THE EFFECTS OF LIGHT INTENSITY,**
Wisconsin Univ.-Madison. Dept. of Bacteriology.
T. B. Parkin, and T. D. Brock.
Limnology and Oceanography, Vol 25, No 4, p 711-718, July, 1980. 5 Fig, 1 Tab, 16 Ref.

Descriptors: *Photosynthetic bacteria, *Lakes, *Light intensity, Primary productivity, Aquatic productivity, Photosynthesis, Chlorophyll, Chlorophyll A, Sulfur bacteria, Sulfur, Phytoplankton, Michigan, Wisconsin.

Six lakes of Michigan and Wisconsin were examined for primary production of photosynthetic bacteria. Productivity of lake water samples was measured in situ by the 14C method. Algal and bacterial photosynthesis were distinguished by the inhibitor DCMU (diuron). Chlorophyll levels were determined colorimetrically and sulfide levels were calculated by a modified methylene blue technique. Bacteriochlorophyll levels ranged from 11.1 to 630 milligrams/cu m. Photosynthetic sulfur bacteria accounted for 0.26 to 6.3% of total daily production in the lakes. No correlations were found between the percentage of photosynthetic bacterial production and the sulfide or bacteriochlorophyll levels in the lake systems studied. Light intensity appeared to be the major parameter controlling the contribution of photosynthetic bacteria to total lake production. (Geiger-FRC)
W81-04828

**COVERING THE OPERATIONAL & HEALTH PROBLEMS ASSOCIATED WITH STORAGE RESERVOIRS,**
Water and Pollution Control, Vol 118, No 3, p 50-52, March, 1980.

Descriptors: *Reservoirs, *Maintenance, Repairing, Water quality, Water quality control, Drinking water, Potable water, *Water treatment.

Once treatment and disinfection has been accomplished it is difficult to ensure that treated water remains at high quality. Maintenance and cleaning schedules of reservoirs and the relationship of chlorine residuals to the presence of coliform and other pathogenic bacteria must be carefully managed. In discussing the Grand Bend treatment plant, which received water from Lake Huron, various problems are dealt with. In examining one reservoir. a slime was removed from the walls which was found to be composed of a matrix of filamentous slime producing bacteria. The mucopolysaccharide material, the slime, serves to protect the bacteria from oxidation by chlorine for a short period of time, thereby protecting potentially harmful organisms. In another reservoir the roof was faulty and contained cracks to the extent that grass, dust, etc., could be seen floating on the surface of the water. At another reservoir vandals had removed valve covers from the top of the reservoir. Necessary changes were made at each reservoir and the quality of the drinking water was improved. (Bakr-FRC)
W81-04849

**SEDIMENTATION IN PROGLACIAL SUNWAPTA LAKE, ALBERTA,**
Queen's Univ., Kingston (Ontario). Dept. of Geography.
R. Gilbert, and J. Shaw.
Canadian Journal of Earth Sciences, Vol 18, No 1, p 81-93, January, 1981. 12 Fig, 27 Ref.

Descriptors: *Sedimentology, *Lake sediments, *Glacial lakes, Sedimentation, Canada, *Sunwapta Lake, Alberta, Hydrologic aspects, Limnology, Lakes, Glacial sediments, Sedimentation rates, Suspended sediments.

The hydrologic and limnologic conditions of Sunwapta Lake, a small proglacial lake located close to the toe of Athabasca Glacier in the Canadian Rocky Mountains, were investigated with special reference to the sedimentology of this lake. Discharge and suspended sediment concentrations of the inflowing streams were measured to give estimates of sediment input. Distribution of large loads of the fine glacial sediment is largely by an inflow- and wind-controlled circulation, which commonly fluctuates diurnally. The spatial distribution of sedimentation was determined by use of sediment-collecting pans placed on the lake bed. The rarity of turbidity currents in the lake is attributed to the high sediment concentration in the lake water, which results from the small size of the lake in relation to the inflow. Sedimentation rates were calculated and six cores from the lake bed, each containing sediment deposited over several years, were analyzed. Although bedding and lamination are found in all cores, correlation between cores was not possible. Sedimentary characteristics are related to inflow and lake conditions: laminated and massive beds of medium to fine sand and silt are related to turbidity events, graded laminae in coarse and fine silt to diurnal variations in lake currents, and massive beds in silt to periods of continuous sedimentation without diurnal variation. Deformed beds result from subaqueous slumps. It is suggested that the sedimentary characteristics described in this report may be useful in the recognition of similar small lakes which were probably common in supraglacial, ice-contact, and proglacial positions during the Pleistocene. (Carroll-FRC)
W81-04863

**PHOSPHOROUS KINETICS IN LAKE SUPERIOR: LIGHT INTENSITY AND PHOSPHATE UPTAKE IN ALGAE,**
Scarborough Coll., Toronto (Ontario).
C. Nalewajko, and K. Lee.
Canadian Journal of Fisheries and Aquatic Sciences, Vol 38, No 2, p 224-232, February, 1981. 6 Fig, 2 Tab, 35 Ref.

Descriptors: *Oligotrophic lakes, *Phosphorus removal, Kinetics, Lakes, *Lake Superior, Great Lakes, Phosphorus, Light intensity, Algae, Productivity, Phytoplankton, Photosynthesis, Algal growth, Limiting nutrients.

The phosphorus demand of Lake Superior phytoplankton was investigated by characterizing the P32-P04 uptake kinetics. Experiments were conducted in August and September, 1979, at two nearshore and two offshore stations. Phytoplankton biomass and chlorophyll a were extremely low, especially at the two offshore stations in August. The chrysomonads Chrysochromulina parva and Uroglena americanum and the diatoms Cyclotella ocellata and C. stelligera were the two predominant groups in the phytoplankton. The N/P ratios in the seston ranged from 8 to 13 and do not support the idea of a severely P-limited population. Most of the total phosphorus to chlorophyll a ratios in Lake Superior were high, at 1.2-9.1, and similar to values in Lake Ontario and Lake Erie. Phosphate uptake rates fitted the Michaelis-Menten equations. Phosphate uptake kinetics were light dependent at very low light levels. It appeared that light and not phosphorus limited phytoplankton growth in Lake Superior at this time. Antecedent solar radiation prior to the experiments coupled with complete mixing of the top 20-25 m of the Lake possibly resulted in a low light adapted phytoplankton population. It is suggested that phosphorus control may not be the correct management strategy to maintain oligotrophy in Lake Superior.(Baker-FRC)
W81-04865

**SEASONAL VARIATIONS IN THE COMPOSITION OF FULVIC ACIDS IN TJEUKEMEER, THE NETHERLANDS, AS STUDIED BY CURIE-POINT PYROLYSIS-MASS SPECTROMETRY,**
Limnological Inst., Oosterzee (Netherlands). Tjeukemeer Lab.
H. de Haan, G. Halma, T. de Boer, and J. Haverkamp.
Hydrobiologia, Vol 78, No 1, p 87-95, 1981. 5 Fig, 2 Tab, 26 Ref.

Descriptors: *Fulvic acids, *Seasonal variations, *Chemical composition, Fate of pollutants, Organic acids, Organic matter, Eutrophication, Algae, Lakes, *Tjeukemeer Lake, Netherlands.

Tjeukemeer is a shallow eutrophic lake used to control the water table of the low-lying surrounding land. During winter, humus-rich water is pumped into the lake; in summer, transparent water enters. In this study the Curie-point pyrolysis-mass spectrometric method was used to analyze monthly water samples (January to September, 1978) for fulvic acid concentration, molecular weight distribution, and chemical composition. In winter, fulvic acids contained relatively high proportions of aromatics and in summer they were relatively rich in carbohydrates, formed in part by production processes in the lake. Aromatics derived from proteins were seen in June and July samples. These were related to the decline of cyanobacteria at that time. Low molecular weight fulvic acid fractions changed more drastically in chemical composition with the seasons than high molecular weight fulvic acids because high molecular weight acids are more resistant to microbial action. It was concluded that hydrology and microbial activity are involved in seasonal changes of chemical composition, concentrations, and molecular weight distributions. (Cassar-FRC)
W81-04902

**LIGHT, SECCHI DISKS, AND TROPHIC STATES,**
Minnesota Univ., Minneapolis. Dept. of Ecology and Behavioral Biology.
For primary bibliographic entry see Field 7C.
W81-04945

**POLLUTION LOADING TO THE GREAT LAKES FROM MUNICIPAL SOURCES IN ONTARIO,**
Nova Scotia Technical Coll., Halifax. Dept. of Civil Engineering.
D. H. Waller, and Z. Novak.
Journal of the Water Pollution Control Federation, Vol 53, No 3, p 387-395, March, 1981. 2 Fig, 14 Tab, 19 Ref.

Descriptors: *Pollution load, *Municipal wastewater, *Great Lakes, *Ontario, Canada, Nonpoint pollution sources, Wastewater treatment, Phosphorus, Water pollution sources, Surface runoff, Combined sewer overflows, Storm wastewater.

An earlier study conducted by the American Public Works Association provided estimates of annual per-acre pollutant loadings, but did not estimate total loadings to the Great Lakes from sources in Ontario, Canada. This study estimates and compares total pollutant loadings from municipal sources in Ontario and relates them to loadings from other sources. The estimates are for the year 1976. Phosphorus is the pollutant of greatest concern with respect to lake-wide effects. This study indicates that storm-generated discharges of surface runoff and combined sewer overflow account for 4 percent of phosphorus loads discharged to the Great Lakes from all Ontario sources and 15 percent of all phosphorus loads discharged to the Great Lakes from municipal sources in Ontario. Reduction of treatment plant effluent concentrations toward a lower limit of 0.3 to 0.5 milligrams per liter would increase the significance of stormwater and combined wastewater loadings. However, the high costs of remedial activities may deter significant reductions of phosphorus loads from stormwater and combined sewer overflows. Surface runoff and combined sewer overflows contribute about equally to total biological oxygen demand and phosphorus loads reaching the Great Lakes. Runoff contains about double the suspended solids and four times the nitrogen loads found in combined sewer overflows. Expressed as concentrations or areal loadings, combined sewer overflows represent more potent pollution sources than surface runoff. (Carroll-FRC)
W81-04953

**COMPARISON OF IN SITU PHOTOSYNTHETIC ACTIVITY OF EPIPHYTIC, EPIPELIC AND PLANKTONIC AGLAL COMMUNITIES IN AN OLIGOTROPHIC LAKE, SOUTHERN FINLAND,**
Helsinki Univ., Lammi (Finland). Lammi Biological Station.
T. Kairesalo.
Journal of Phycology, Vol 16, No 1, p 57-62, 1980. 3 Fig, 2 Tab, 18 Ref.

Descriptors: *Primary productivity, *Algae, *Photosynthesis, *Lakes, Phytoplankton, Epiphytes, Epipelon, Productivity, *Oligotrophic lakes, Paajarvi Lake, Finland.

Photosynthetic activity of three types of algal communities was measured near the shore of the oligotrophic Paajarvi Lake, Finland. relative production rate of phytoplankton was greatest, three times that of epiphyton, and 20 times that of epipelon. Epiphyton productivity was constant while algal volume varied greatly, suggesting that the surface layer of the algal community was mainly responsible for the phytosynthetic activity. At 1 meter depth primary production per sq meter of lake surface was similar in all three algal types, but at 2-4 meters phytoplankton production was twice that of epipelon. Phytoplankton productivity per cu meter of water was nearly equal to that of epiphyton and epipelon per sq meter of substratum at the same irradiance. (Cassar-FRC)
W81-04974

**PHOSPHORUS UTILIZATION AND STORAGE IN BATCH CULTURES OF THE DINOFLAGELLATE PERIDINIUM CINCTUM F. WESTII,**
Weizmann Inst. of Science, Rehovot (zisreal). Dept. of Isotopes Research.
A. Elgavish, G. A. Elgavish, M. Halmann, and T. Berman.
Journal of Phycology, Vol 16, No 4, p 626-633, 1980. 8 Fig, 4 Tab, 30 Ref.

Descriptors: *Dinoflagellates, *Phosphorus, Nutrients, Lakes, Chemical composition, Algae, Phytoplankton, Eutrophication, *Kinneret Lake, Israel.

Cultures of Peridinium cinctum f. westii were isolated from Lake Kinneret. This is the predominant alga in the phytoplankton of Lake Kinneret, which forms an annual bloom prevailing from January to June. External orthophosphate concentrations were depleted by successive transfers to increasingly lower initial orthophosphate concentrations from 200, 50, 5, 0.6 and 0.2 microM. Lower cell yields were obtained as othophosphate concentrations diminished, but groth rates were not affected. This effect on cell yields was caused by a decrease in an intracellular P pool unextractable by cold 6% trichloroacetic acid. The major constituents of this internal phosphorus pool in phosphate-rich cells were the polyphosphates, as determined by NMR. These polyphosphates were organized in rigid aggregates of low mobility. Electron dense bodies observed in phosphate enriched cells further supported the existence of an aggregate structure of the polyphosphates. It was concluded that excess othophosphate was stored as polyphosphates by P. cinctum, and this accumulates in a rigid morphological structure. (Baker-FRC)
W81-04975

**PERIODICITY OF EPIPELIC UNICELLULAR VOLVOCALES (CHLOROPHYCEAE) IN A SHALLOW ACID POOL,**
University Coll. of North Wales, Bangor. School of Plant Biology.
C. M. Happey-Wood.
Journal of Phycology, Vol 16, No 1, p 116-128, 1980. 14 Fig, 2 Tab, 50 Ref.

Descriptors: *Benthic flora, *Flagellates, *Epipelon, Chlamydomonas, Chloromonas, Volvocales, Chlorophyceae, Nutrients, Algae, Lakes, Seasonal variation, Productivity, Water quality, *Oligotrophic lakes, Priddy Pool, England.

Occurrence, periodicity, and growth of 20 species of volvocales were studied in Priddy Pool, England, a shallow, oligotrophic, acidic pool occupied by emergent macrophytes. Standing crops fluctuated rapidly, with minimum populations in winter. Greatest species diversity and primary production were seen in late spring-early summer and in autumn. Chlamydomonads were more numerous in the epipelon; growth occurred after the diatom standing crop had reached a maximum. Rates of Chlamydomonad primary productivity were greatest in late spring and late summer when growth rates of unicellular Volvocales were high. Ordination analysis showed a positive relatioship between bicarbonate-alkalinity and chlamydomonad population. There was no correlation with phosphate, nitrate, or silica concentrations. (Cassar-FRC)
W81-04977

**HOT WATER EXTRACTABLE PHOSPHORUS--AN INDICATOR OF NUTRITIONAL STATUS OF PERIDINIUM CINCTUM(DINOPHYCEAE) FROM LAKE KINNERET (ISRAEL),**
Israel Oceanographic and Limnological Research Ltd., Tiberias.
For primary bibliographic entry see Field 5A.
W81-04978

**WIND-INDUCED WATER MOVEMENTS IN THE SOUTH BASIN OF WINDERMERE,**
Freshwater Biological Association, Windermere (England).
D. G. George.
Freshwater Biology, Vol 11, No 1, p 37-60, 1981. 21 Fig, 3 Tab, 34 Ref.

Descriptors: *Water currents, *Wind-driven currents, *Water temperature, Wind velocity, Lakes, Water circulation, Flow patterns, Thermal stratification, Epilimnion, Hypolimnion, Windmere South Basin, Great Basin.

The general form of water circulation in the South Basin of Windermere, which is the largest lake in the Lake District of Great Britain, was investigated. Lagrangian methods using drift bottles and depth-specific drogues were used to measure water movements. The results of these direct current measurements were related to wind history and horizontal variations in the near-surface water temperature. Internal seiche movements were found to have little effect on horizontal transport in the epilimnion except during periods when sudden calms followed strong winds. Direct wind forcing was the most important factor governing mass water movement, with variations in wind speed accounting for about 93 percent of the variation in near-surface current speed. There was a marked decrease in the current speed-wind speed relationship with increasing wind speeds between 100 and 500 centimeters per second, with the wind factor remaining relatively constant at wind speeds above 500 centimeters per second. Coriolis effects deflected near-surface currents between 4 and 38 degrees to the right of the wind and produced pronounced rotations, with depth, of the wind-driven current. The strength of this rotation was greatest at low wind speeds with a deep thermocline. Although horizontal variations in water temperature ranged from only 0.2 C to 1.0 C per kilometer, they served as a good indirect tracer of the circulation pattern. (Carroll-FRC)
W81-04997

**CIRCULATION AND SEDIMENTATION IN A TIDAL-INFLUENCED FJORD LAKE: LAKE MCKERROW, NEW ZEALAND,**
New Zealand Oceanographic Inst., Wellington.
R. A. Pickrill, J. Irwin, and B. S. Shakespeare.
Estuarine, Coastal and Shelf Science, Vol 12, No 1, p 23-37, 1981. 8 Fig, 27 Ref.

Descriptors: *Sedimentation, *Water circulation, *Tidal effects, Flow characteristics, Fjords, Lakes, Suspended sediments, Saline lakes, Estuaries, *New Zealand, *Lake McKerrow, Limnology, Hydrology.

Lake McKerrow is a fjord lake in New Zealand which has freshwater overlying entrapped saline water and which is separated from the open sea by a Holocene barrier spit. Unlike most fjord lakes, Lake McKerrow is tidal and there is occasional renewal of the saline bottom water from the open ocean. During winter, the lake waters are stratified, with cold, oxygen saturated freshwater in the epilimnion overlying warmer, saline deoxygenated water in the hypolimnion. Freshwater from the Upper Hollyford River at the head of the lake flows over the pycnocline during winter, depositing coarse silts on the steep delta face and transporting finer silts and clays down-lake. Large-scale mixing between the inflowing river water and the deep saline water is limited by the salinity stratification and by the slow replenishment of the saline hypolimnal waters. A well-developed sub-lacustrine channel system on the forest slope of the river delta suggests that density or turbidity currents flow down the forest slope. However, it is unlikely that these currents extend beyond the epilimnion. During the ebb tide, fresh surface water containing fine terrigenous suspended particulate matter flows down the river to the sea, and some of this water is returned on the flood tide. Diatom rich oceanic saline water may flow back into the lake during periods of high spring tides and low lake levels. This water flows downslope into the lake basin as a density current in a well defined channel. However, the volumes of saline water flowing into the lake are small and infrequent. (Carroll-FRC)
W81-04999

## 2I. Water In Plants

**GROWTH OF CUCUMBER UNDER WATER AND TEMPERATURE STRESS,**
Oklahoma State Univ., Stillwater. Dept. of Horticulture.
R. E. Reaves, M. B. Kirkham, and A. G. Taylor.
Journal of Arid Environments, Vol 3, No 2, p 113-115, 1980. 1 Fig, 17 Ref.

Descriptors: *Crop yield, *Moisture stress, *Thermal stress, Stress, Stomata, Plant growth, Growth rates, Arid climates, *Cucumber.

This study was designed to determine which of the following is more detrimental to cucumber growth: high temperature with optimal moisture or moisture stress with optimal temperature. Cucumis sativus L. 'Country Fair' was grown in two growth chambers. The high-temperature chamber was maintained at 40 deg C during the day and 30 deg C during the night. The low-temperature one was 30 deg during the day and 20 deg during the night. Water stress was imposed to uniform seedlings by adding polyethylene glycol 6000 in two 1-bar steps on the fifth and ninth day. Growth was determined using a leaf-area meter. For both the low and high temperature treatments, stomatal resistance increased with water stress. Plants with a lower resistance grew more than plants with a high resistance. Thus, moisture stress with optimal temperature was more detrimental to the growth of the cucumbers than high temperature with optimal moisture. Under controlled environment conditions, it would be more important to maintain optimal moisture than optimal temperature. (Small-FRC)
W81-04836

**DROUGHT STRESS AND ITS EFFECTS ON MAIZE REPRODUCTIVE SYSTEMS,**
Illinois Univ. at Urbana-Champaign. Dept. of Argonomy.
M. P. Herrero, and R. R. Johnson.
Crop Science, Vol 21, No 1, p 105-110, January/February, 1981. 3 Fig, 2 Tab, 18 Ref.

Descriptors: *Crops, *Drought, Agriculture, Crop yield, *Corn, Water stress, Moisture, Temperature effects, Thermal stress, Drought resistance.

The purpose of this study was to determine more clearly which aspects of corn fertilization are detrimentally affected by drought stress occurring at tassel emergence. The findings demonstrated that portions of the synchronization of male and female floral development were affected by drought stress induced during flowering. Since prophyll emergence and pollen shed was also not affected by the stress, but there was a general decrease in this interval as planting date was delayed. Under conditions of severe stress silking was delayed until after all or much of the pollen had shed, thereby creating large numbers of barren or poorly filled ears. Delayed silk emergence and concomitant silk elongation represented the most sensitive portion of the floral synchronization process to plant water status. Ears often silked within the ear leaf sheath, thus preventing possible pollination. Results also suggest that during pollen development, high temperatures are more detrimental than drought stress. (Baker-FRC)
W81-04870

**CELL MEMBRANE STABILITY AS A MEASURE OF DROUGHT AND HEAT TOLERANCE IN WHEAT,**
Volcani Inst. of Agricultural Research, Bet-Dagan (Israel).
A. Blum, and A. Ebercon.
Crop Science, Vol 21, No 1, p 43-47, January/February, 1981. 5 Fig, 2 Tab, 9 Ref.

Descriptors: *Crops, *Drought, Agriculture, Moisture deficiency, Water deficit, Water shortage, Water stress, Moisture stress, *Wheat, Membranes, Heat tolerance, Drought resistance.

An adaptation and evaluation of Sullivan's method was applied to drought and heat tolerance in wheat. Additional information was also obtained in barley and triticale. The drought tolerance test used is based on the measurement of the electroconductivity of aqueous media containing leaf discs that were previously water stressed in vitro by exposure to a solution of polyethylene glycol-6,000. The heat tolerance test is similarly based on exposure of leaf discs to heating, in vitro, to 44 degrees C. With increasing plant age, the drought tolerance of wheat leaves decreased. Some variation was noted in drought tolerance in relation to leaf position. Wheat was more drought resistant than maize, sorghum or millet. During periods of water stress, previously dry plants were more drought tolerant than well-watered plants. This finding suggests that cell membrane stability adapts to drought stress. Drought and heat tolerance were not correlated in wheat. (Baker-FRC)
W81-04871

**THE EFFECTS OF FLOODING ON THE SWAMP FOREST IN LAKE OCKLAWAHA, FLORIDA,**
Southeastern Forest Experiment Station, Charleston, SC. Forestry Sciences Lab.
W. R. Harms, H. T. Schreuder, D. D. Hook, C. L. Brown, and F. W. Shropshire.
Ecology, Vol 61, No 6, p 1412-1421, December, 1980. 3 Fig, 6 Tab, 16 Ref.

Descriptors: *Flooding, *Artificial lakes, *Trees, Mortality, Water depth, Ecological effects, Swamps, Florida.

The relationship between flooding depth and mortality of the major tree species was investigated in Lake Ocklawaha, Florida, from the spring of 1972 to the fall of 1975. Also, the physiological responses of tree roots to flooding were determined. Tree mortality was closely related to water depth in all species, but did vary with species and diameter. Carolina ash, baldcypress, red maple, and swamp tupelo were the major species present. All trees had died after three years in those parts of the reservoir flooded in excess of 1.3 m; at 0.8 mortality averaged 41%, at 0.7 m it averaged 17%, and at 0.2 m it averaged 2%, which was about the same as natural mortality. Baldcypress, swamp tupelo, and cabbage palm were the most flood tolerant, while oaks were the least tolerant. Larger trees had lower mortalities at all flooding depths, and mortality was least in trees whose diameter was greater than 38 cm. As the water depth increased, the porortion of the root systems killed by flooding increased, and the amount of starch in tissues of living roots decreased. (Small-FRC)
W81-04874

**INFLUENCE OF SUNLIGHT ON PHOTOSYNTHESIS, WATER RELATIONS, AND LEAF STRUCTURE IN THE UNDERSTORY SPECIES ARNICA CORDIFOLIA,**
Wyoming Univ., Laramie. Dept. of Botany.
D. R. Young, and W. K. Smith.
Ecology, Vol 61, No 6, p 1380-1390, December, 1980. 3 Fig, 3 Tab, 37 Ref.

Descriptors: *Photosynthesis, *Light intensity, *Plant physiology, Radiation, On-site investigations, Stomata, Stomatal transpiration.

This investigation was designed to compare the phenotypic plasticity in photosynthesis, water relations, and leaf structure of Arnica cordifolia Hook, a herbaceous perennial. Field measurements of plant water relations were made to compare the possible intraspecific differences between sun and shade plants. Stomatal resistance to water vapor diffusion, air and leaf temperatures, and water vapor concentrations of ambient air were measured along with windspeed, and transiration was calculated. Field measures of photosynthesis were also taken in sun and shade under natural conditions. In sun and shade plants, significant differences were found in sunlight patterns and windspeeds which lead to differences in leaf temperature, stomatal resistance, xylem water potentials, and photosynthesis. Leaf size, thickness, and trichrome density also varied. Stomatal opening occurred for both sun and shade plants during sunlit periods which caused large increases in photosynthesis and transpiration. Higher photosynthetic rates, light saturation values, and temperature optima for photosynthesis were found in sun plants. (Small-FRC)
W81-04875

**FIRST APPROXIMATION OF THE EFFECTS OF RAINFALL ON THE ECOLOGY AND ENERGETICS OF A NAMIB DESERT DUNE ECOSYSTEM,**
Desert Ecology Research Unit, Walvis Bay (Namibia).
M. K. Seely, and G. N. Louw.
Journal of Arid Environments, Vol 3, No 1, p 25-54, 1980. 12 Fig, 2 Tab, 51 Ref.

Descriptors: *Dunes, *Rainfall impact, *Moisture stress, Desert plants, Precipitation, Arid climates, Plant growht, *Ecosystems, Ecology, *Namib Desert, Africa.

Ecological studies were conducted in the Namib dunes after a prolonged dry period and after a high rainfall event. Before the rain fell, the biomass data collected was the lowest for any terrestrial system: plants 2.6 gm/sq m, detritus 0.4 gm/sq m, and animals 0.01 gm/sq m. After the rain, the biomass increased significantly, primarily due to the groth of ephemeral grasses. The potential energy contained in the plant biomass increased ninefold, that for the detritus increased sevenfold, and that for animals increased sixfold. The rain caused niche overlap, expansion of home ranges of animals, and changes in the distribution patterns ofplants. The most important limiting factors in the ecology of the dnes were water, nitrogen and phosphorus content of the dune sand, and the physical stability of the sandy substrate. The low protein content of vegetation during dry periods was thought to be the limiting factor for herbivore and omnivore populations. The ecosystem was unique in the absence of a microbiological decomposition loop, the degradation of accumulated detritus by tenebrionid beetles, and the dependence of biota on fog. (Small-FRC)
W81-04979

## 2J. Erosion and Sedimentation

**SEDIMENT-POLLUTANT RELATIONSHIPS IN RUNOFF FROM SELECTED AGRICULTURAL, SUBURBAN, AND URBAN WATERSHEDS; A STATISTICAL CORRELATION STUDY,**
Tetra Tech, Inc., Lafayette, CA.
S. W. Zison.
Available from the National Technical Information Service, Springfield, VA 22161 as PB80-158108, Price codes: A07 in paper copy, A01 in microfiche. Environmental Protection Agency Report EPA-600/3-80-022, January, 1980. 147 p, 17 Fig, 44 Tab, 36 Ref, 2 Append.

Descriptors: *Agricultural watersheds, *Urban watersheds, *Statistical analysis, *Mathematical models, *Storm runoff, Sediments, Pollutants, Urban runoff, Agricultural runoff, Mass transfer, Water quality, Regression analysis.

Data from agricultural, suburban, and urban watersheds were subjected to statistical correlation analysis to estimate potency factors. These factors are coefficients that, when multiplied by sediment mass emission rates (transported in runoff), provide estimates of mass emission rates for other pollutants. The potency factors are required input for such lumped-parameter runoff models as the Nonpoint Source (NPS) Model and the Stormwater Management Model (SWMM). The temporal variance of suspended sediment concentration in storm runoff can account for a relatively small proportion of the temporal variance of nearly all other water quality constituents considered. Potency factors computed for urban runoff are more reliable than those developed for suburban, rural, and agricultural areas. There is a large degree of uncertainty in the values, so care must be taken in applying them in models of non-urban watersheds. The data were also subjected to multiple regression analysis to examine the effect of storm parameters on runoff water quality and the interrelationship among runoff water quality constituent concentrations themselves (other than sediment load). The multiple regression analysis was primarily exploratory with the objectives of explaining variance of water quality and identifying important independent or predictor variables rather than developing predictive expressions.(Brambley-SRC)
W81-04710

**DREDGING IN ILLINOIS,**
Illinois State Water Survey, Urbana.
For primary bibliographic entry see Field 2H.
W81-04731

**BED EROSION IN RECTANGULAR LONG CONTRACTION,**
Ahmadu Bello Univ., Zaria (Nigeria). Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W81-04765

**ULTIMATE DIMENSIONS OF LOCAL SCOUR,**
Science and Education Administration, Minnapolis, MN.
F. W. Blaisdell, C. L. Anderson, and G. G. Hebaus.
Journal of the Hydraulics Division, Proceedings of the American Society of Civil Engineers, Vol 107, No HY3, p 327-337, March, 1981. 5 Fig, 1 Tab, 8 Ref.

Descriptors: *Scour, *Mathematical studies, Comparison studies, *Erosion rates.

Because scour approaches its limit asymptotically, current methods of estimating the ultimate depth of scour are based on specifying a practical limit, which is based on personal judgment and can vary widely among individuals. This paper describes an analytical method of estimating the ultimate depth of scour which is based on experimental observations made over a relatively short period of time during the early stage of the scouring process and which is independent of individual judgment. The method involves plotting the logarithm of the rate of change of the scour dimension against the logarithm of time. A hyperbolic curve is fitted to the plotted data, and the asymptote of the hyberbola is used to determine the ultimate scour dimension. An example is used to compare the hyperbolic logarithmic method with the linear logarithmic and linear semi-logarithmic methods (in which the scour depth increases without limit), which require an estimate of the time required to reach a practical equilibrium. The hyperbolic logarithmic method predicts both the progression of scour with time and the ultimate scour dimensions. If a practical scour dimension is desired, the hyperbolic method of analysis will provide a prediction equation for any practical time period and also evaluate the difference between the practical and the ultimate dimensions. The method may also be applicable to determination of such other dimensions of local scour as the length and width of the scoured area and the location of the scour with respect to the pipe exit, pier, or other source of local scour. (Carroll-FRC)
W81-04768

**BED-LOAD TRANSPORT UNDER WAVES AND CURRENTS,**

National Oceanic and Atmospheric Administration, Miami, FL. Atlantic Oceanographic and Meteorological Labs.
C. E. Vincent, R. A. Young, and D. J. P. Swift.
Marine Geology, Vol 39, No 3/4, p M71-M80, 1981. 4 Fig, 22 Ref.

Descriptors: *Wave action, *Currents, *Bed load, Mathematical equations, *Sediment transport, Sand.

Data from past work on laboratory experiments on sediment transport by waves and currents is analyzed. Kalkanis (1964) and Abou-Seida (1965) used oscillating sand beds with recessed traps to study the accumulation rate. In contrast to the work of Madsen and Grant (1976), the accumulation rate is interpreted as a measure of the average concentration of bed load per unit area during the period of oscillation for which the Shields Number exceeds the threshold Shields Number. For runs in which the Reynolds Number exceeds 35, the volume concentration of bed load is directly proportional to the excess Shields Number, and the volume transport rate under instantaneous flow velocity is proportional to the volume concentration of bed load and wave induced current close to the bed. Testing these relationships with the data of Manohar (1955) produced good agreement, better at high rates than the equation of Madsen and Grand (1976). An equation for transport rate is proposed which has a firmer physical basis than some of the other wave transport equations in use. (Cassar-FRC)
W81-04821

**DEVELOPMENT OF PIPING EROSION CONDITIONS IN THE BENSON AREA, ARIZONA, U.S.A.,**

Jordon Univ., Amman. Dept. of Civil Engineering.
Y. M. Masannat.
Quarterly Journal of Engineering Geology, Vol 13, No 1, p53-61, 1980. 6 Fig, 4 Tab, 24 Ref.

Descriptors: *Erosion, *Soil erosion, *Piping erosion, Soil types, *Arizona, Benson area, Semiarid lands, Surface runoff, Alluvium, Gully erosion, Vegetation.

Piping, a subsurface form of erosion, produces pipe-like channels leading toward a discharge exit. This condition, affecting 50% of agricultural lands in the study area of Benson, Arizona, was observed in two forms: pipes with roughly circular cross sections, with steep gradients near the inlet and gradually sloping less toward the outlet; and stress-crack pipes which develop upon drying and extend throughout the entire soil profile. Most piping in this semi-arid country was seen in alluvial deposits bordering arroyo cuts or actively degraded stream channels. Typical soils subject to piping were silts and silty sands with low clay content, low dry density, high void ratios, and easy collapsibility. Major causes of this erosion in the San Pedro Valley were overgrazing and a decline in water table and artesian head from drought conditions. Although piping was seen in areas of both low and high vegetation density, highly eroded land contained little plant life because pipes had drained the subsurface moisture. Increased piping erosion is generally caused by lowering of the levels of the erosional channels into which the pipes outflow; presence of paths for water flow from desiccation cracks, fissures, animal burrows, and plant root channels; increase in surface runoff from a poorly permeable surface or lack of vegetative cover; soil stratification; and light, unstable soil. (Cassar-FRC)
W81-04858

**GROWTH PATTERNS OF THE ACHELOOS AND EVINOS DELTAS, WESTERN GREECE,**

Patras Univ. (Greece). Geological Lab.
D. J. W. Piper, and A. G. Panagos.
Sedimentary Geology, Vol 28, No 2, p 111-132, 1981. 10 Fig, 16 Ref.

Descriptors: *Sediment transport, *Deltas, *Flood control, Acheloos River, Evinos River, *Greece, Rivers, Dams, Progradation, Sedimentation, River mouth, Fluvial sediments, Coastal plains, Geomorphology, Coastal zone management, Braided streams, Meanders, Stream discharge, Sediment discharge, Tides.

The coastal plain complex on the noth side of the Gulf of Patras, Greece, has been formed from overlapping deltas of the Acheloos and Evinos Rivers. This paper describes the growth pattern of the delta complx and the sedimentary facies (subaerial delta plain, river mouth, beach, tidal flats, lagoons, submarine delta platform, and pro-delta slope). Upstream channels are braided; delta channels are meandering. Before flood regulation, both rivers had a high water discharge, 77% of annual. Two dams, built on the Acheloos in 1966 and 1969, have changed the sediment distribution and growth pattern of the delta. Former annual suspended sediment dicharge was 3-4 million tons and bed load discharge, two million tons in the Acheloos. The freshwater muddy plume of the Acheloos formerly was visible up to 15 km offshore. Very silty sediments are found within a few km of the shore and clays, further offshore. At present, the Acheloos mouth features a long arcuate emergent bar formed since flood control construction. River discharge is confined to two channels at either end. The two or three distributaries formerly present within 1 km of the mouth of the Acheloos have disappeared. Old maps and aerial photos allowed tracing of progradation and erosion at the river mouth. Flood control has greatly reduced these processes. The Evinos mouth is shoal and has no emergent bar. (Cassar-FRC)
W81-04976

**GRAVEL FABRIC IN A SUB-HIMALAYAN BRAIDED STREAM,**

Delhi Uni. (India).
S. K. Tandon, and R. Kumar.
Sedimentary Geology, Vol 28, No 2, p 133-152, 1981. 13 Fig, 2 Tab, 19 Ref.

Descriptors: *Sedimentology, *Gravel, *Braided streams, Streams, Particle shape, Particle size, Chakki River, India, Sediment distribution.

A modern braided stream, Chakki River, in the Beas River system, India, was investigated to provide information for understanding deposition processes in the deformed Upper Tertiary Siwalki formations of the Himalayan molassic phase. The imbrication of AB planes reveals a close correspondence with channl direction, deviations seldom exceeding 30 degrees. At some locations large deviations are caused by increases in sinuosity and existence of subsidiary channels. A current-normal mode exists for the A-axis orientation data. Bimodal distributions are recognized and attributed to shifting flow conditions. The range in mean values of the dip of AB planes is between 22.6 and 37.6 degrees, and the mean values of plunge of the A-axis vary from 2.9 to 13.2 degrees. There is a marked decrease in plunge of the A-axis in the downstream direction of the river, but the dip of AB-planes shows no systematic variation in the section of river studied. Particle size versus orientation analysis shows a strong upcurrent imbrication, independent of size. A particle shape versus orientation approach shows that the A-axis orientation is independent of particle shape. Both the bladed and tabular particles show a strong upcurrent imbrication, with deviations of up to 30 degrees from the channel trend. The A-axis lies almost normal to the channel trend in most cases. (Cassar-FRC)
W81-04983

**COASTAL AND NEAR-SHORE CHANGES CORRELATED WITH DIE-BACK IN EELGRASS (ZOSTERA MARINA, L.),**

Aarhus Univ. (Denmark). Lab. of Physical Geography.
C. Christiansen, H. Christoffersen, J. Dalsgaard, and P. Nornberg.
Sedimentary Geology, Vol 28, No 3, p 163-173, 1981. 6 Fig, 1 Tab, 26 Ref.

Descriptors: *Sea grasses, *Coastal morphology, *Sediment transport, Sand, Marine plants, Aquatic plants, Sedimentation, Rooted aquatic plants, Kyholm, Denmark, Harbors.

The decline of eel grass (Zostera marina L.) due to higher water temperatures and resulting destruction by fungi and bacterial diseases was responsible for alterations in coastal morphology in the harbor of Kyholm, Denmark. According to analyses of 1 to 2 meter sediment cores taken in conjunction with studies of a 13th century shipwreck in the harbor, progradation and reworking of the sandy strata occurred during 2 periods of eel grass die-back in this century. Such sediment disturbances explain the sparseness and random distribution of archeological finds in the harbor. Maps from 1832 to 1933 show negligible changes in the coastline shape. Marked changes took place between 1933 and 1954. During this time the coast moved seawater by 30 meters and small coves filled with sand. No significant shoreline changes took place between 1954 and 1961, during which eel grass reestablished. From 1961 to 1969 eel grass again declined and the coastline advanced another 35 meters seaward. No substantial changes have been observed since 1969. (Cassar-FRC)
W81-04984

**PARTICLE INTERACTIONS IN FJORD SUSPENDED SEDIMENT,**

Calgary Univ. (Alberta). Dept. of Geology and Geophysics.
J. P. M. Syvitski, and J. W. Murray.
Marine Geology, Vol 39, No 3/4, 1981. 15 Fig, 3 Tab, 79 Ref.

Descriptors: *Suspended sediments, *Sedimentation, *Flocculation, *Fjords, *Howe Sound, British Columbia, Turbidity, Mixing, Zooplankton, Glacial sediments, Stratification, Water currents.

Sedimentation of glacially and fluvially derived sediments entering a fjord was investigated in Howe Sound, British Columbia. The surface-layer sediment plume moves quickly down the inlet while slowly mixing with marine water. Mixing and diffusion are the dominant mechanisms for sediments to enter the lower marine water. During high river discharge periods, more than 50% of the initial suspended load leaves the fjord. Several days are required for surface particles to settle to the lower marine layer. Five particle types have been identified: sand and silt grains with attached clay particles, clay clasts possibly related to river mudballs, zooplankton fecal pellets, large grain and colloidal floccules, and inorganic-biogenic agglomerates. Water stratification and currents below the surface layer are indicated by variations of sediment rates and size distribution between levels in the water column. Bottom resuspension is absent. Immature clastic sediments intermixed with siliceous biogenic fragments deposit in fjords receiving large amounts of glacial runoff. A hypothesis of particle interaction in Howe Sound suspended sediments is presented. Flocculation, aggregation, and agglomeration are active. (Cassar-FRC)
W81-04985

**EXPERIMENTS ON NON-CHANNELIZED TURBIDITY CURRENTS AND THEIR DEPOSITS,**

Eidgenossische Technische Hochschule, Zurich (Switzerland).
S. Luthi.
Marine Geology, Vol 40, No 3/4, p M59-M68, 1981. 3 Fig, 16 Ref.

Descriptors: *Turbidity currents, *Sedimentology, *Deposition, Currents, Particle size, Silt, Quartz, Experimental data.

Laboratory experiments in a basin 10 x 6 x 1 meters showed that non-channelized turbidity currents produce a wide flow opening angle (about 90 degrees), and rapid dilution of the current with distance takes place. The thickness of the deposit decreased radially away from the source (by half for each meter along the axis and more rapidly in a lateral direction), resulting in tongue-shaped isopachs. Mean grain diameter decreased with distance; lines of equal grain diameters had almost semi-circular shapes; and sorting improved with distance. Three suspension densities of quartz silt were used--1.0070, 1.0238, and 1.0675 grams per cu cm. The two less-concentrated suspensions produced slightly wider opening angles and almost semi-circular contours of the moving front rather than tongue-shaped contours. Bedforms were as

follows, starting closest to the source: non-deposition, parallel lamination, ripples and parallel lamination. This corresponds with the B-C-D division of the Bauma sequence for turbidities. The A division was absent because the initial suspension concentration was too low. The E division was lacking because of minimal clay fractions. (Cassar-FRC)
W81-04986

**CAESIUM IN THE UP-ESTUARY TRANSPORT OF SEDIMENTS,**
Exeter Univ. (England). Dept. of Geology.
J. R. Merefield.
Marine Geology, Vol 39, No 3/4, p M45-M55, 1981. 4 Fig, 4 Tab, 20 Ref.

Descriptors: *Sediment transport, *Cesium, *Barium, *Strontium, Heavy metals, Metals, *Estuaries, Path of pollutants, Teign estuary, Marine sediments, Fluvial sediments, Saline-freshwater interfaces, Rivers, Clays.

Sources of sediments are identified in the Teign estuary, England, using trace elements. There are three zones of sediments: river (1.9 km in length), mixed (5.5 km), and marine (1.9). Barium derived from past mining activities characterizes river input. Concentrations of Ba in the estuary sediments vary between 91 and 6919 ppm. Where the Ba values reach the regional threshold of 350 ppm, the lowest limit of these sediments is defined. Strontium from skeletal debris marks the landward transport of marine-derived sediments. Sr ranges from 78 to 19 ppm in the fraction smaller than 250 micrometers, decreasing landward from the mouth of the estuary. Cesium is traced to estuarine and coastal outcrops of Permian sandstones. Cs levels reach a maximum of 85 ppm in the mixed sediment zone. This element is largely present in the clay fraction (40-230 ppm) and argillaceous lithic material (60-180 ppm). Thus Cs could be a useful marker of transport of argillaceous sediments. (Cassar-FRC)
W81-04987

**SANDY HIGH-ENERGY FLOOD SEDIMENTATION--SOME CRITERIA FOR RECOGNITION, WITH AN EXAMPLE FROM THE DEVONIAN OF S.W. ENGLAND,**
Reading Univ. (England). Sedimentology Research Lab.
I. P. Tunbridge.
Sedimentary Geology, Vol 28, No 2, p 79-95, 1981. 9 Fig, 57 Ref.

Descriptors: *Sedimentation, *Alluvial deposits, *Ephemeral streams, *Floods, Sandstones, Deposition, Semiarid lands, Sedimentary rocks, Parallel lamination.

The Trentishoe Formation (Hangman Sandstone Group, Middle Devonian), England, shows similarity to disposition patterns produced by modern ephemeral flows. Coastal outcrops of this continental-derived formation expose up to 15 meters of parallel-laminated, fine-grained red sandstones in layers up to 1 meter thick, which extend laterally for hundreds of meters. Several instances of the sequence--erosion surface, sparse silt clasts, parallel laminations, silt drape--are found, suggesting formation by high flow stage deposition of plane-bedded sand, followed by rapid waning of flow with silt fallout in the final stages of the flood. Modern ephemeral flows in semiarid regions with sparse vegetation often produce sheet floods which spread widely over the landscape. Many sands deposited by such action are almost entirely parallel-laminated, sometimes thinning to ripple cross-laminated sands at the margins. These patterns are not seen in deposits from perennial streams. Comparison with descriptions in the literature of modern flood deposits from ephemeral flows supports the conclusion that ancient parallel-laminated, sand-dominated alluvial deposits may have been produced by ephemeral flows. (Cassar-FRC)
W81-04994

## 2L. Estuaries

**NUTRIENT POOLS OF AN ESTUARINE ECOSYSTEM--THE BLACKWOOD RIVER ESTUARY IN SOUTH-WESTERN AUSTRALIA,**
Western Australia Univ., Nedlands. Dept. of Botany.
R. A. Congdon, and A. J. McComb.
Journal of Ecology, Vol 68, No 1, p 287-313, March, 1980. 11 Fig, 15 Tab, 39 Ref.

Descriptors: *Nutrients, *Vegetation, *Nitrogen compounds, Phosphorus compounds, Sediments, Estuaries, Blackwood River, *Australia, Aquatic life, Salinity.

Nutrient cycling was studied in the Blackwood River estuary, Australia, which contains nearly fresh water in winter and stratified saline water in summer. Nutrient levels in the water are low in summer and significantly higher in winter. The highest inorganic phosphorus concentration in water was 14 micrograms per liter, much lower than that in many other estuaries. Ratios of nitrate-N to orthophosphate-P ranged from 56:1 in July to 19:1 in August. The sediments were nutrient-rich. The bird population probably contributes nutrients to the system via fecal material and disturbing sediments. Nitrogen fixation occurs in many of the estuary ecosystems. A major pool of nutrients is the marginal vegetation which releases nutrients to the system upon decay. (Cassar-FRC)
W81-04651

**RESULTS AND EVALUATION OF A PILOT PRIMARY MONITORING NETWORK, SAN FRANCISCO BAY, CALIFORNIA, 1978,**
Geological Survey, Menlo Park, CA. Water Resources Div.
For primary bibliographic entry see Field 7A.
W81-04674

**GLUCOSE EXCHANGES IN A SALT MARSH-ESTUARY: BIOLOGICAL ACTIVITY AND CHEMICAL MEASUREMENTS,**
Skidaway Inst. of Oceanography, Savannah, GA.
R. B. Hanson, and J. Snyder.
Limnology and Oceanography, Vol 25, No 4, p 633-642, July, 1980. 7 Fig, 2 Tab, 16 Ref.

Descriptors: *Glucose, *Salt marshes, *Phytoplankton, Bacteria, Seasonal variation, Estuaries, Marshes, Tidal marshes, Duplin River, Sapelo Island, Doboy Sound, *Georgia, Heterotrophic bacteria, Aquatic plants, Benthic fauna.

Glucose uptake and concentrations were determined in a Spartina alterniflora salt marsh estuary, Duplin River, Sapelo Island, Georgia, to ascertain the source and fate of glucose in the system. In the marsh, Spartina, plankton, and benthic algae are the obvious sources of glucose. In the estuary, phytoplankton is the major source. In the river, microheterotrophs (bacteria, yeasts, and possibly some algae) are the major glucose users. Concentrations of glucose varied along the length of the river, with the tides, and with the seasons. In summer, mean glucose concentrations showed 2 gradients: one from high glucose Doboy Sound toward the transition zone and a second from the high glucose headwaters toward the transition zone. March glucose levels were higher (5-20 micrograms per liter) than August levels (1-10 micrograms per liter). Activity in the 3 micrometer fraction decreased from Doboy Sound toward the transitional zone and increased from the transition zone toward the headwaters. Little, if any, glucose leaves one system and mixes with the other under stable hydrological conditions; most of the glucose is recycled within each system.
W81-04824

**GROWTH RATES OF PSEUDOPEDINELLA PYRIFORME (CHRYSOPHYCEAE) IN RESPONSE TO 75 COMBINATIONS OF LIGHT, TEMPERATURE AND SALINITY,**
Maryland Univ., College Park. Dept. of Botany.
C. R. Ostroff, E. P. Karlander, and S. D. Van Valkenburg.
Journal of Phycology, Vol 16, No 3, p 421-423, 1980. 3 Fig, 17 Ref.

Descriptors: *Growth rates, *Algae, Brackish water, Estuaries, Light penetration, Temperature, Cultures, Salinity, Pseudopedinella, Chrysophyceae, *Chesapeake Bay.

Axenic cultures of Pseudopedinella pyriforme Carter isolated from the Chesapeake Bay showed maximum growth (0.9 doublings per day) at 2.5 parts per thousand salinity, 571 microW per sq cm, and 15C. A total of 75 combinations of temperature (5, 10, and 15C), salinity (2.5, 5, 7.5, 10, and 15 parts per thousand) and white light (143, 285, 428, 571, and 714 microW per sq cm) were tested. A salinity of 5 parts per thousand produced the fastest growth at most light intensities up to 428 microW per sq cm and temperatures of 5 to 15C. (Cassar-FRC)
W81-04839

**POPULATION GENETICS OF SKELETONEMA COSTATUM (BACILLARIOPHYCEAE) IN NARRAGANSETT BAY,**
Rhode Island Univ., Kingston. Graduate School of Oceanography.
J. C. Gallagher.
Journal of Phycology, Vol 16, No 3, p 464-474, 1980. 2 Fig, 5 Tab, 51 Ref.

Descriptors: *Genetics, *Diatoms, *Population dynamics, Algae blooms, Skeletonema, Phytoplankton, Adaptation, Estuaries, Seasonal variation, *Narragansett Bay, Rhode Island.

Genetic examination of the diatom, Skeletonema costatum, showed that the winter bloom population was genetically different from the prevalent summer bloom population of the same species. Allozyme banding patterns were examined for five enzyme loci. Although the blooms had distinct prevalent forms, they were not genetically homogeneous. No single clone was representative of all the populations. No year to year variation in frequency of prevalent forms was detected. These genetically different diatoms are identical in form. Therefore, differences are not detectable by routine cell counts. It is probable that the annual phytoplankton cycle of Narragansett Bay is a function of the presence of an array of genetically variable populations and of the appropriate environmental conditions for their growth. (Cassar-FRC)
W81-04840

**SIMULATION MODEL OF SKELETONEMA COSTATUM POPULATION DYNAMICS IN NORTHERN SAN FRANCISCO BAY, CALIFORNIA,**
Geological Survey, Menlo Park, CA.
J. E. Cloern, and R. T. Cheng.
Estuarine, Coastal and Shelf Science, Vol 12, No 1, p 83-100, 1981. 10 Fig, 1 Tab, 45 Ref.

Descriptors: *Simulation analysis, *Phytoplankton, *Population dynamics, Mathematical models, Plankton, Estuaries, *San Francisco Bay, California.

Since phytoplankton dynamics govern other dynamic properties of the water column in estuaries, it is necessary to understand the factors regulating phytoplankton productivity and biomass in order to understand estuaries as ecological systems. A numerical model was developed to simulate population dynamics of one dominant phytoplankton species, Skeletonema costatum, in the northern San Francisco Bay estuary. The model was developed in order to test hypotheses concerning mechanism regulating phytoplankton biomass in the Bay, to provide initial estimates of the relative magnitudes of individual processes governing phytoplankton dynamics in this estuary, to assist in the planning of field studies, and to lay a foundation for long-term development of realistic ecosystem models. The model is formulated around a conceptualization of the estuary as two distinct but coupled subsystems; a deep central channel and lateral areas with shallow water and slow circulation. The methods used to compute convection and dispersion in the chan-

nel, in situ phytoplankton growth and death rates, lateral exchange between the channel and the shoals, and estuarine gravitational circulation are described. The results of application of the model to the testing of hypotheses about mechanisms regulating phytoplankton population dynamics in the Bay are discussed, and recommendations for further refinement of the model and new directions for field studies are presented. (Carroll-FRC)
W81-04893

**DYNAMICS, DIFFUSION AND GEOMORPHOLOGICAL SIGNIFICANCE OF TIDAL RESIDUAL EDDIES,**
Nederlands Inst. voor Onderzoek der Zee, Texel.
J. T. F. Zimmerman.
Nature (London), Vol 290, No 5807, p 549-555, April, 1981. 4 Fig, 2 Tab, 45 Ref.

Descriptors: *Suspended sediment, *Tidal currents, *Geomorphology, Eddies, Sediment transport, Water currents, Eddy diffusion, Tides.

Tidal residual eddies are largely explained by quasi-two-dimensional vorticity dynamics together with coastal geometry and/or bottom morphology providing tidal vorticity gradients. Not only residual currents should be taken into account in residual sediment transport, but also the nonlinearly generated higher harmonics in the tidal velocity field, known as over-tides. However, if sediment transport can be expressed as a function of the vertically averaged velocity, this may not be a serious flaw of the quasi-two-dimensional theory, since overtides appear as a by-product of residual current theory. Thus the two-dimensional approach requires incorporation into the theory of a description of the interaction between sea-bed morphology and the tidal current regime. This theory could be used to explain whether bottom morphology is static or whether it may shift in space over time. There is no relevant three-dimensional theory, but for problems of suspended sediment transport, the tidally varying vertical distribution of suspended load and velocity is important in producing residual transport. Also, veering of tidal and residual currents near sand ridges is not explained by a two-dimensional theory. (Small-FRC)
W81-04907

**ACCURACY OF AN ESTUARINE HYDRODYNAMIC MODEL USING SMOOTH ELEMENTS,**
Geological Survey, Menlo Park, CA. Water Resources Div.
R. A. Walters, and R. T. Cheng.
Water Resources Research, Vol 16, No 1, p 187-195, February, 1980. 5 Fig, 4 Tab, 20 Ref.

Descriptors: *Estuarine environment, *Hydrodynamics, Estuaries, Coasts, Fluid mechanics, Flow characteristics, *San Francisco Bay, Boundary conditions, *Model studies, Mathematical models.

Some numerical experiments used to assess the performance of an estuarine hydrodynamic model were designed to address the problem of how to treat boundary conditions at open or shoreline boundaries, by using smooth curve-sided elements at all shoreline boundaries. The model uses mixed interpolation and was developed from an earlier model of King. The model is a finite element model which uses triangular, isoparametric elements with quadratic basis functions for the two velocity components and linear basis functions for water surface elevation to compute shallow water wave motions. The accuracy of the model is tested with a set of numerical experiments in rectangular and curvilinear channels with constant and variable depth. The results indicate that errors in velocity at the open boundary can be significant when boundary conditions for water surface elevation are specified. Methods are suggested for minimizing these errors. The results also show that continuity is better maintained within the spatial domain of interest using the smooth curve-sided elements at shoreline boundaries than when piecewise linear boundaries are employed. A method for network development is described based on a continuity criterion to gauge accuracy. A finite element network for San Francisco Bay, California, is used as an example. (Baker-FRC)
W81-04917

**ESTIMATES OF VASCULAR PLANT PRIMARY PRODUCTION IN A WEST COAST SALTMARSH-ESTUARY ECOSYSTEM,**
Oregon Univ., Eugene. Marine Biology Inst.
J. R. Hoffnagle.
Northwest Science, Vol 54, No 1, p 68-79, February, 1980. 3 Fig, 6 Tab, 23 Ref.

Descriptors: *Salt marshes, *Plant growth, Vegetation regrowth, Plants, Ecosystems, Marshes, Tidal marshes.

Vascular plant primary production in the salt marshes of the Coos Bay estuary was assessed as a first step toward measuring organic detrital influx into the estuary. Monthly samples were taken in each marsh along permanent transect lines to determine aerial and root standing crop values. When the primary production values were being assessed, estimations were made of death due to shedding and herbivory and included in these assessments. The greatest productivity, 1200 g/sq/ m/year, was evidenced in the salt marshes with a predominance of giant bulrush, Scripus validus. The least productivity, 400 g/sq m/year was demonstrated in disturbed marshes. High intermediate characteristics were noted in salt marshes with a predominance of Carex lyngbei and Distichlis spicata. Root standing crop values appeared quite large, at 20,000 g/sq m. The importance of this plant material to estuarine food chains should be investigated in future studies. (Baker-FRC)
W81-04944

**DDT CONTAMINATION AT WHEELER NATIONAL WILDLIFE REFUGE,**
Fish and Wildlife Service, Laurel, MD. Patuxent Wildlife Research Center.
For primary bibliographic entry see Field 5B.
W81-04962

**HYDRODYNAMICS OF A TIDAL CREEK-MANGROVE SWAMP SYSTEM,**
Australian Inst. of Marine Science, Townsville.
E. Wolanski, M. Jones, and J. S. Bunt.
Australian Journal of Marine and Freshwater Research, Vol 31, No 4, p 431-450, 1980. 14 Fig, 24 Ref.

Descriptors: *Hydrodynamics, *Mathematical models, *Tidal rivers, *Swamps, Mangrove swamps, Streams, Flow characteristics, Flow pattern, Coastal marshes, Coastal waters, Sediments, Evapotranspiration, *Australia, Missionary Bay, Coral Creek.

Coral Creek is a tidal creek draining extensive and thickly vegetated tropical mangrove swamps in Missionary Bay, Hinchinbrook Island, Australia. Although the creek is deep and shows no sign of siltation, the large sediment load in the coastal waters has resulted in extensive siltation of the surrounding sheltered coastline. A mathematical model was used to successfully simulate the hydrodynamics of the tidal creek-mangrove swamps system. The model showed that a net down-stream longitudinal current exists through the swamps and is responsible for the rapid export of organic detritus from the swamps to the ocean. Addition of a sediment transport model demonstrated that the creek is self-scouring only because of the presence of surrounding mangrove swamps. The size and geometry of the creek's drainage channel are related to vegetation density in the swamps. A positive longitudinal gradient in salinity results from evapotranspiration from mangroves in the creek and from the absence of a freshwater discharge into the creek. The evapotranspiration rate in the swamp may be as high as 3 centimeters per day. Residual currents in Missionary Bay are clockwise, explaining the overall pattern of scour and deposition in the Bay. (Carroll-FRC)
W81-04966

**CAESIUM IN THE UP-ESTUARY TRANSPORT OF SEDIMENTS,**
Exeter Univ. (England). Dept. of Geology.
For primary bibliographic entry see Field 2J.
W81-04987

**PLANKTONIC BACTERIA IN THE HUMBER ESTUARY; SEASONAL VARIATION IN POPULATION DENSITY AND HETEROTROPHIC ACTIVITY,**
Hull Univ. (England). Dept. of Plant Biology.
E. J. Bent, and R. Goulder.
Marine Biology, Vol 62, No 1, p 35-45, 1981. 5 Fig, 2 Tab, 30 Ref.

Descriptors: *Heterotrophic bacteria, *Seasonal variation, *Suspended solids, Estuaries, Bacteria, Humber Estuary, England.

Bacterial counts and heterotrophic activity in the Humber Estuary, England, varied seasonally, being low in summer and high in autumn through spring. The density of attached bacteria (2.8 million per ml in August, 1978, to 40.7 million per ml in January, 1978) was dependent on the concentration of suspended solids, which was similarly low in summer and high in winter. Densities of free bacteria fluctuated irregularly (0.8 million to 7.0 million per ml) and showed no seasonal pattern, being independent of suspended solids concentration. There was no significant correlation between densities of free bacteria and attached bacteria. The above measurements were made at Hull over a two year period. Investigations at Saltend and Brough over a one year period showed a similar pattern in densities of attached bacteria, but densities were less: Saltend, 0.4 to 16.6 million per ml, and Brough, 3.9 to 20.1 million per ml. Free bacteria at these two sites also fluctuated irregularly. Values were 1.4 to 5.2 million per ml at Saltend and 1.2 to 6.4 million per ml at Brough. Total heterotrophic activity showed seasonal variations, low in summer, high in winter, at Hull; 0.09 micrograms per liter per hour were found in June, 1978, and 6.1 micrograms per liter per hour in November, 1979. Activity at Saltend and Brough showed no seasonal patterns, probably as a result of limitations of data rather than differences in sites. (Cassar-FRC)
W81-04991

**SEASONAL CHANGES IN INTERSTITIAL SALINITIES AND SEASONAL MOVEMENTS OF SUBTIDAL BENTHIC INVERTEBRATES IN THE FRASER RIVER ESTUARY, B.C.,**
Victoria Univ. (British Columbia). Dept. of Biology.
P. M. Chapman, and R. O. Brinkhurst.
Estuarine, Coastal and Shelf Science, Vol 12, No 1, p 49-66, 1981. 8 Fig, 2 Tab, 39 Ref.

Descriptors: *Interstitial water, *Benthic fauna, *Seasonal variation, Salinity, Seasonal distribution, Estuaries, *Fraser River, Canada, *British Columbia, Invertebrates, Oligochaetes, Polychaetes.

A series of six sampling stations were established in the Fraser River in British Columbia, spaced to encompass the whole spectrum from seawater to freshwater regimes, in order to investigate the seasonal shifts in interstitial salinity and the correlation between these shifts and shifts in the distribution of benthic infaunal species. The subtidal benthic fauna in the salt-wedge estuary of the Fraser River was sampled monthly from June 1977 to August 1978 in mud substrates at the six stations. The study results show that the interstitial salinities do not follow diurnal salinity variations in the overlying water, but change cyclically at all stations in relation to river flow. This cyclical change results in seasonal shifts in the distribution of the subtidal benthic invertebrates. Seasonal shifts were shown to occur in seven species of oligochaetes and three polychaetes. These ten species comprised over 25 percent of the total taxa collected and over 60 percent of the total individuals collected. Data on other species distributions do not conflict with the hypothesis of cyclic changes related to seasonal interstitial salinities. The system of the occurrence of seasonal faunal shifts appears to be stable over long time periods and to be a feature of salt-wedge estuaries in general. (Carroll-FRC)
W81-05000

# 3. WATER SUPPLY AUGMENTATION AND CONSERVATION

## 3A. Saline Water Conversion

**MEMBRANE/WATER DISTRIBUTION AND DIFFUSION OF NICKEL ION IN CELLULOSE ACETATE MEMBRANES,**
Istituto di Recercha sulle Acque, Bari (Italy).
G. Mossa, R. Passino, and M. Pegoraro.
Desalination, Vol 34, No 1/2, p 57-67, July-August, 1980. 5 Fig, 1 Tab, 12 Ref.

Descriptors: *Desalination, *Reverse osmosis, *Membranes, Membrane processes, Cellulose acetate membranes, Cellulose acetate, Diffusion, Nickel, Ions.

The possibility of removing metals from aqueous solutions by reverse osmosis (RO) on cellulose acetate (CA) membranes was investigated. Practical results were compared with Glueckauf's physical model of electrolyte distribution. NiSO4 solutions with concentrations ranging from 0.1 to 0.001 M were used. Values of diffusion coefficients were found to be 10 to the minus 13th power square centimeters per second and practically independent of salt concentration. The distribution coefficient data varied as a function of the external solution concentration in accordance with Anderson's treatment of electrolyte sorption. The data gathered from this experiment are in satisfactory agreement with Glueckauf's physical model of distribution at sufficiently high concentrations. (Baker-FRC)
W81-04803

**KEY WEST TAPS THE SEA,**
Public Works, Vol 112, No 4, p 66-67, April, 1981. 1 Fig.

Descriptors: *Reverse osmosis, *Desalination plants, *Desalination, Membrane processes, Demineralization, Drinking water, Water treatment, Water treatment facilities, Florida.

A reverse osmosis plant leased by the Florida Keys Aqueduct Authority supplies Key West with an additional three mgd of drinking water. A pipeline from Florida City on the mainland is the city's primary water supply source. The plant was designed to reduce the total dissolved solids loading from 38,000 mg/liter to less than 500 mg/liter. A permeator is the actual mechanism that removes dissolved solids from the water. Every cylindrical permeator contains a million or more hollow fibers which act as filtering membranes. Dissolved salts and other minerals in the feedwater are continuously flushed out of the permeator as reject water. The permeator has removed at least 98.5% of the dissolved solids. Plastic and stainless steel are used throughout the plant to resist salt water corrosion. Post-treatment of the water includes degasification to remove carbon dioxide and hydrogen sulfide, and the pH is adjusted to 7.5 before the water is stored. (Small-FRC)
W81-04814

**ON THE ECONOMICS OF DESALINATION OF BRACKISH HOUSEHOLD WATER SUPPLIES,**
New Mexico State Univ., Las Cruces. Dept. of Agricultural Economics and Agricultural Business.
J. T. McGuckin, and R. A. Young.
Journal of Environmental Economics and Management, Vol 8, No 1, p 79-91, March, 1981. 2 Tab, 16 Ref.

Descriptors: *Desalination, *Brackish water, *Economic evaluation, Saline water, Damage, Domestic water, Mathematical models, Financial feasibility, Arkansas Valley, Colorado.

A model for salinity reduction is formulated and applied to three communities in the Arkansas Valley, Colorado, a region noted for its highly saline water supply. Chemical constituents in household water supplies can cause economic damage in the form of reduced life of appliances and pipes. First, it is demonstrated that the traditional partial analysis which employs a single variable optimization is incorrect when applied to household water desalination. Current empirical data necessary to parametrize a salinity reduction model are reviewed. When the model and cost data were applied to three communities, the analysis indicated that the estimated benefits of desalination exceeded costs for some communities with highly saline waters. Thus, desalination is feasible in communities with populations greater than 5000 persons and with very saline (greater than 1500 TDS) water supplies. Desalination is not feasible when estimates of salinity damages are lower than those usually made. Further research is needed to determine the real extent of salinity damages. (Small-FRC)
W81-04862

**TREATMENT BY REVERSE OSMOSIS OF CERTAIN SOLUTIONS CONTAINING TWO SOLUTES, ONE ORGANIC AND ONE INORGANIC,**
New South Wales Univ., Kensington (Australia). School of Chemical Engineering.
M. J. Clifton, and R. T. Fowler.
Desalination, Vol 34, No 1/2, p 25-34, July/August, 1980. 3 Fig, 1 Tab, 22 Ref.

Descriptors: *Reverse osmosis, *Membrane processes, *Solutes, Desalinization, Electrolytes, Water treatment, Osmosis, Inorganic compounds, Organic compounds.

According to experimental results obtained on a commercial membrane module, equations describing reverse osmosis treatment of single solute solutions were applicable, with corrections, to solutions containing both an ionic and a nonionic solute. The combinations of solutes used were: sodium nitrate-urea, sodium nitrate-glucose, sodium sulfate-urea, sodium sulfate-glucose, sodium sulfate-glucose. Some solute-solute coupling was observed, but its effect on the flux of a particular solute was never more than 10% of the total. In some cases a negative coupling coefficient was observed, indicating the existence of a slight complexation effect. (Cassar-FRC)
W81-04879

## 3B. Water Yield Improvement

**THE UNDERWATERED WEST. OVERDRAWN AT THE WELL,**
D. Sheridan.
Environment, Vol 23, No 2, p 6-13, 30-33, March, 1981. 1 Fig, 1 Tab, 34 Ref.

Descriptors: *Arid lands, *Water supply development, Arid-zone hydrology, *Water conservation, Water demand, Water harvesting, Agricultural hydrology, Desalination, Cloud seeding, Irrigation water, Overdraft.

The population of the arid regions of the western United States has probably exceeded the areas' carrying capacity in relation to water supply. More groundwater has been pumped out of the ground for use in irrigation than nature has put back in. Also, the damming of rivers to make water available on demand and the transporting of water from abundant areas to where it is scarce have upset the natural hydrology of the West. Silt deposits from land cultivation have increased shorelines and dried up lake beds. Three federal agencies are presently engaged in research on a major aquifer on the Southwest, the Ogallala. The Central Valley project authorized by Congress in 1933 encompasses several projects to increase the water supplies of California. Interbasin transfers are being investigated as a possible means to increase water supplies in arid areas. Other technologies being considered which are still in the planning stage include the transport of Antarctic icebergs to the California coast, the desalination of seawater, cloud seeding and soft technologies such as the conservation of irrigation water and the development of salt-tolerant crops. Another soft technology under investigation is the modification of vegetation to increase water runoff while supporting livestock. In general, nontechnical, nonstructural responses to the West's water problem have gained little support. (Geiger-FRC)
W81-04895

## 3C. Use Of Water Of Impaired Quality

**LONG-TERM EFFECTS OF LAND APPLICATION OF DOMESTIC WASTEWATER; MESA, ARIZONA: IRRIGATION SITE,**
Stone (Ralph) and Co., Inc., Los Angeles, CA.
R. Stone, and J. Rowlands.
Available from the National Technical Information Service, Springfield, VA 22161 as PB80-203144, Price codes: A12 in paper copy, A01 in microfiche. Environmental Protection Agency Report EPA-600/2-80-061, April, 1980. 264 p, 14 Fig, 36 Tab, 185 Ref, 8 Append.

Descriptors: *Wastewater irrigation, *Leachates, *Groundwater pollution, *Land disposal, Bacterial analysis, Wastewater disposal, Soil contamination, Crop yield, Pathogens, Nutrients, Heavy metals, Salts, Flood irrigation, Furrow irrigation, Coliforms.

The widespread application of treated wastewater for irrigation is limited primarily by certain economic, technical and public health uncertainties about the impacts of such use. The concentrations of pathogens, nutrients, heavy metals and salts in soils, groundwater, and crops irrigated with secondary-treated wastewater were compared to the concentrations in soils, groundwater and crops irrigated with conventional water supplies. Test and control sites at Mesa, Arizona, were selected as case studies for comparisons. Both sites produced ensilage or other crops not intended for human consumption. The control site was furrow irrigated and the test site was flood and furrow irrigated. Data indicate that no constituent in the test site leachate was significantly different from the control site leachate at 50 cm subsurface depths, and total coliform, magnesium and nickel were significantly lower for the 100 cm test site leachate. Total dissolved solids increased in the leachate entering the upper groundwater at both sites. The organic content in the effluent as indicated by the total organic carbon and total and fecal coliform were effectively attenuated by percolation through the soil. The groundwater samples at the test exceeded water quality standards more often than control site groundwater for total coliform, fluorides, and arsenic; they exceeded the standards less often for chloride and chromium. Crop yields for barley, sorghum, and wheat were similar over a 13 year period on the test and control sites. The total cost of the crops on the test site was less than the cost on the control site due to the use of effluent at no cost in place of purchasing potable water and fertilizer. (Moore-SRC)
W81-04714

**LYSIMETER AND FIELD STUDIES ON LAND APPLICATION OF WASTEWATER SLUDGES,**
Environmental Protection Service, Burlington (Ontario).
M. D. Webber, Y. K. Soon, and T. E. Bates.
Water Science and Technology, Vol 13, No 2, p Tor 905-917, 1981. 3 Fig, 3 Tab, 15 Ref.

Descriptors: *Land disposal, *Crop yield, *Groundwater pollution, Aluminum, Iron, Calcium, Alum, Sludge, Phosphorus, Corn, Wheat, Grasses.

Results obtained during 1973 to 1977 from field and lysimeter experiments conducted at Burlington, Ontario and Guelph, Ontario are reported. The studies were made to determine the effects on crop yield and water quality of groundwater following land applications of sludges containing aluminum, iron, and calcium. The wastewater had been treated with these chemicals as alum to remove phosphorus. Sewage sludge applications increased the yield of orchard grass, bromegrass, wheat and corn to the same levels or beyond

surpassing those achieved using commercial fertilizers. Even with sludge applications of 499 tonnes/ha dry solids there was no reduction in this achievement. These results indicated that the application of sludge to the land would not reduce crop yield or quality for these test crops, nor would it reduce the quality of the groundwater. (Baker-FRC)
W81-04805

**PROVING THE BENEFITS OF LAND DISPOSAL OF SLUDGE,**
Monroe County Div. of Pure Waters, Rochester, NY.
T. Quinn, and J. Pitts.
Public Works, Vol 112, No 4, p 60-63, April, 1981. 4 Tab.

Descriptors: *Land disposal, *Sludge, Cost-benefit analysis, Economic aspects, Cost analysis, Monitoring, Crops, Vegetation, Wastewater treatment facilities, *Sludge conditioning.

Sludge conditioning, equipment required, procedure and frequency of monitoring pollutants, types of crops planted and analysis of crops and soil are discussed, as they relate to experiences gained at the Northwest Quadrant plant, situated in the northwest corner of Greece, New York. This plant is designed to treat 15 mgd and has a present average flow rate of 12.6 mgd. The operation results in 12 tons of sludge per day on a dry solids basis. The flow scheme involves mechanical screening and grit removal, primary settling, activated sludge treatment followed by secondary settling, addition of alum for phosphorus removal, and effluent chlorination. Effluent is discharged to Lake Ontario, with phosphorus limited to 1 milligram per liter. Land application was approached as an alternative to year round sludge incineration. The method used allows a single pass to be made over the land site, during which sludge cake is aplied in a uniform layer, plowed under, disked and rolled so that no sludge is left exposed. A program of monitoring surface and groundwater was established to insure that no environmental damage was resulting from the sludge applications. After four years of experience in comparing methods this pilot project has been both economically and environmentally justified. Overall results suggest that a saving of $180,000 in fuel oil costs over the 3-yr period has been realized. (Baker-FRC)
W81-04818

**A MODEL FOR OPTIMAL IRRIGATION SCHEDULING WITH SALINE WATER,**
Hebrew Univ., Rehovoth (Israel). Agricultural Economic Research Center.
D. Yaron, E. Bresler, H. Bielorai, and B. Harpinist.
Water Resources Research, Vol 16, No 2, p 257-262, April, 1980. 2 Fig, 44 Ref.

Descriptors: *Model studies, *Irrigation, Irrigation design, Irrigation engineering, *Impaired water use, Irrigation programs, Semiarid lands, Arid lands, Saline soils, Salinity, Soil moisture deficiency.

A short run dynamic programming model is presented for optimal scheduling of irrigation with water of varying salinity levels and soil salinity parameters. The use of this model should allow one to determine whether a preplanting leaching should be applied and in what amount, given the initial soil salinity. The model should also allow one to determine the optimal irrigation scheduling, the combination of quantities and the timing during the entire irrigation season. The application of the model to optimal scheduling of irrigation with saline water to sorghum crop is described. The area where the model was tested was the Gilat semiarid area of Israel. Since computer simulation of the water-soil-crop system is considerably cheaper than field experiments, it can be used as a means for screening irrigation policies to help decide on more expensive and more reliable field experiments to follow. One refinement suggested for the model is to refer to distinct soil layers such as 30 cm depth for each layer, and to compute the moisture and salinity for each layer. (Baker-FRC)
W81-04912

**SALT TOLERANCE OF GLASSHOUSE-GROWN MUSKMELON,**
Volcani Inst. of Agricultural Research, Bet-Dagan (Israel). Dept. of Soil and Water.
A. Meiri, and Z. Plaut.
Soil Science, Vol 131, No 3, p 189-193, March, 1981. 2 Fig, 6 Tab, 7 Ref.

Descriptors: *Drip irrigation, *Salt tolerance, *Crop yield, Saline water, Irrigation water, Fruit crops, Water pollution effects.

Drip irrigation of muskmelons (Cucumis melo L.) with 5 concentrations (EC--electrical conductivity--1.5 to 7.1) of saline water in a glasshouse suppressed the fruit number, weight, netting, and evapotranspiration rate. The number of fruit increases slightly for the 2.4 and 3.6 EC water and decreased to 90% for the 7.1 EC water. Average fruit weights were 647 grams for the 1.5 EC water to 525 grams for the 7.1 EC water. At 1.5 EC salinity 76% of the fruits were netted (marketable) and at 7.1 EC, 57%. The ratio of soil solution salinity to irrigation water salinity decreased as irrigation water salinity rose. In the initial growth stages (first 1-2 months) soil water salinity was close to that of irrigation water. (Cassar-FRC)
W81-04932

## 3D. Conservation In Domestic and Municipal Use

**METHODS OF CONTROLLING HUMAN USE OF A LAKE.,**
Bloomington Water Dept., IL.
D. W. Ferguson.
In: Proceedings of a Round Table on Reclaiming and Managing Lake in Illinois, October 10-11, 1980. Illinois Institute of Natural Resources, Chicago, Document No 81/06, February, 1981. p110-113.

Descriptors: *Land management, *Water supply, *Resources management, Leases, Management planning, Lake restoration, Multiobjectie planning, Legal aspects, Property boundaries, Public access, Shore protection, Public lands, Administrative regulations, Bloomington, *Illinois, Water management.

Bloomington's water supply comes from two man-made lakes, built 30 years apart, which are managed quite differently. One lake is controlled by city employees; the other has minimal city control, but instead is controlled by lease agreement. Shoreline area around Lake Bloomington, built in 1929-30 for water supply, was subdivided and leased for 99 years with strict requirements regarding shoreline maintenance, cleanliness and maintenance of lots, and guidelines for septic tank and tile drain fields for the lots. All leases cease at a contour line which is five feet, vertically, above the spillway overflow elevation; however, the leaseholder is given use of the water. The threat of lease cancellation sufficies to enforce these regulations, and regular city garbage collection discourages lake litter. Boat speeds and safety features are monitored by a special security officer employed at the lake. Lake Evergreen, on the other hand, was built in 1968-71 with no shore leases. Instead, there is a park area with nature trails, a swimming area, and public campgrounds. Both County and City officials maintain and regulate lake use, as it is managed under a lease agreement with the County Parks and Recreation Department. As a result, when water supply for the City is needed, recreation continues without interruption. The report concludes that both methods of control work well and are appropriate in municipal situations. (Garrison-Omniplan)
W81-04755

## 3F. Conservation In Agriculture

**METHODOLOGY FOR OPTIMIZATION OF AN IRRIGATION SYSTEM WITH STORAGE RESERVOIRS,**
Idaho Univ., Moscow. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 8A.
W81-04653

**A CASE HISTORY STUDY TO DOCUMENT THE EFFECTIVENESS OF WATER USE EFFICIENCY RESEARCH,**
New Mexico State Univ., Las Cruces.
W. Cunningham, and R. P. Herman.
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-240566, Price codes: A03 in paper copy, A01 in microfiche. New Mexico Water Resources Research Institute, New Mexico State University, Report No 133, May, 1981. 21 p, 7 Fig, 2 Tab. OWRT-C-00075-T(No 4023)(1), 14-34-0001-0423.

Descriptors: *Water conservation, *Water use efficiency, *Irrigation efficiency, Research programs, Federal sponsored programs, Evaluations, Southern Plains, *Furrow diking, Low energy precision application, Drip irrigation, Benefit analysis, Effectiveness assessment.

In October of 1979, the Office of Water Research and Technology (OWRT) asked state water institutes to assess the effectiveness of OWRT sponsored research and to develop documented case history studies. The objective of the project was to conduct a regional analysis of the effectiveness of water use efficiency research in the Southern Plains. Due to the wide scope of this field, the study focused on two specific techniques often used together: furrow diking and low energy precision application irrigation (LEPA). The study concluded that OWRT-sponsored research has resulted in pratical designs for these two water and energy saving technologies. It found that the decision of a farmer to implement a technology is based primarily on positive experiences with the techniques on neighboring farms. Low initial investment technology (furrow diking) was found to spread rapidly compared to technology with a higher initial cost (LEPA). The sponsored research was found to be cost effective since the total federal investment in research to develop these systems represents less than 0.01 percent of a conservative estimate of the savings from using them.
W81-04662

**A REGIONAL ASSESSMENT OF THE ECONOMIC AND ENVIRONMENTAL BENEFITS OF AN IRRIGATION SCHEDULING SERVICE,**
Economics, Statistics and Cooperative Service, Washington, DC. Natural Resources Economics Div.
M. J. English, G. J. Horner, G. T. Orlob, J. Erpenbeck, and M. Moehlman.
Available from the National Technical Information Service, Springfield, VA 22161 as PB80-192404, Price codes: A07 in paper copy, A01 in microfiche. Environmental Protection Agency Report EPA-600/2-80-063, April, 1980. 124 p, 30 Fig, 27 Tab, 44 Ref, 1 Append. EPA-IAG-D6-0121.

Descriptors: *Irrigation efficiency, *Scheduling, *Environmental effects, *Cost analysis, *Water use, Benefits, Computers, Model studies, Simulation, Deep percolation.

Irrigation scheduling is a technique for systematically determining the proper date and quantity of each irrigation in individual fields. This technique is presently being used in the western United States to assist farmers in planning irrigations. However, the advantages and disadvantages of an irrigation scheduling service have not been clearly established. The analytical procedure developed for determining the benefits of an irrigation scheduling service for this project required both field data and simulation modeling. The study area was the A and B Irrigation District, a 76,800 acre district located on the Snake River in southern Idaho. Although the A and B Irrigation District's average water use is relatively efficient, there is substantial variability in scheduling practices of individual farmers. An irrigation scheduling service operating in the district could produce important environmental and economic benefits, but the benefits would vary from one farmer to another. The potential reduction in irrigation costs would pay the

cost of a scheduling service in most instances. Substantial reductions in total water use and deep percolation could be brought about with the use of an irrigation scheduling service. The potential benefits of a scheduling service can be largely nullified by deviations from the prescribed irrigation schedule in terms of timing and quantity of water applied. (Moore-SRC)
W81-04722

**CONTROLLED THRUST OSCILLATING SPRINKLER,**
R. A. Rodriguez.
U.S. Patent No 4,221,333, 14 p, 17 Fig, 6 Ref; Official Gazette of the United States Patent Office, Vol 998, No 2, p 505, September 9, 1980.

Descriptors: *Patents, *Sprinkler irrigation, *Application equipment, Irrigation practices, Irrigation efficiency, Irrigation operation and maintenance.

A sprinkler having low internal resistance, to allow its operation at low fluid pressures and which can irrigate varying wedge-shaped portions of land, alternately pivots about a vertical axis. Means contained within the sprinkler cause the expulsion of water under pressure, first from one tangentially mounted nozzle, and next through an opposed but commonly aligned tangentially mounted nozzle. The torque generated by the alternating expulsion effects the rotation of the sprinkler first in one angular direction, and then in an opposite angular direction. Buffing means is provided to limit the speed of angular rotation. (Sinha-OEIS)
W81-04742

**METHOD OF AND SYSTEM FOR UNDERGROUND IRRIGATION,**
World Seiko Kabushiki Kaisha, Nagaoka (Japan). (Assignee).
K. Saburi.
U.S. Patent No 4,221,501, 12 p, 14 Fig, 11 Ref; Official Gazette of the United States Patent Office, Vol 998, No 2, p 562, September 9, 1980.

Descriptors: *Patents, *Irrigation systems, *Subsurface irrigation, Application equipment, Irrigation practices, Capillary action.

At least one hollow water permeable member is embedded in soil to be irrigated. The water permeable member includes a wall having fine capillary pores. A supply source of water is maintained at a negative water pressure. A feed pipe connects the supply source of water to the interior of the water permeable member. Water passes through the feed pipe to the water permeable member and permeates through the capillary pores into the surrounding soil by means of a pressure difference between the negative water pressure of the supply source and the lower negative pressure within the soil resulting from the degree of absorptivity of the soil. (Sinha-OEIS)
W81-04744

**SUB-SURFACE IRRIGATION CHANNEL,**
For primary bibliographic entry see Field 8A.
W81-04745

**WATER RESOURCES PLANNING FOR IRRIGATION SYSTEMS,**
Technical Univ. of Prague (Czechoslovakia).
For primary bibliographic entry see Field 6A.
W81-04782

**THE UNDERWATERED WEST. OVERDRAWN AT THE WELL,**
For primary bibliographic entry see Field 3B.
W81-04895

**A DYNAMIC MODEL OF CORN YIELD RESPONSE TO WATER,**
Kansas Agricultural Experiment Station, Manhattan.
T. H. Morgan, A. W. Biere, and E. T. Kanemasu.
Water Resources Research, Vol 16, No 1, p 59-65, February, 1980. 8 Fig, 1 Tab, 13 Ref.

Descriptors: *Crop yield, *Water stress, Irrigation, *Corn, Water shortage, Water loss, Water scarcity, Agriculture, Irrigation design, *Irrigation practices, Management, Water management.

A dynamic model of corn yield response to daily available soil moisture is presented. The model measures crop response by incorporating certain physiological knowledge of the plant. Thus it does not require a prohibitively large number of observations to estimate the response function. It is a dynamic growth and development model based on present knowledge of plant growth and development and of plant response to water stress. The model does not deal with the impact of soil fertility on plant response to water stress. With the estimated model it is possible to simulate the corn yields for various irrigation schedules. The simulations demonstrate the sensivitity of the model to the timing of irrigations. The model has at least two applications; first to analyze presently used irrigation practices, and second to analyze dryland cropping strategies where rainfall patterns are known in a stochastic sense. Use of the method for scheduling irrigation should provide improved information on the marginal value of water to be used in forming water management policy. (Baker-FRC)
W81-04918

**ON-FARM WATER MANAGEMENT FOR RURAL DEVELOPMENT,**
Colorado State Univ., Fort Collins. Dept. of Agricultural Engineering.
W. Clyma, M. K. Lowdermilk, and D. Lattimore.
Agricultural Engineering, Vol 62, No 2, p 14-15, February, 1981.

Descriptors: *Model studies, *Irrigation efficiency, *Farm management, Farming, Irrigation, Rural areas, Developing countries, Planning, Water management.

A three-phase development model was developed to improve irrigation systems around the world. The three basic phases are: problem identification, development and assessment of solutions, and implementation of solutions at the farm level. In Pakistan the government organized a $40 million on-farm water management program to implement the package of solutions developed and tested on small farms in the Punjab. The development model was used with an interdisciplinary team of specialists including agricultural engineers, agronomists, sociologists, and economists. The Pakistan program has proved so successful that less and less incentive has to be offered to get farmers to participate. Utilizing the model to design and implement a farm water management program in Egypt has also proved successful in defining problems and developing solutions. Problems such as nonlevel fields, enormous water losses in on-farm delivery systems, and poor irrigation practices have been found in every developing nation where the model has been applied. Thus, the role of the agricultural engineer has been a large one. (Small-FRC)
W81-04936

**WATER USE AND WHEAT YIELDS IN NORTHERN INDIA UNDER DIFFERENT IRRIGATION REGIMES,**
Central Soil and Water Conservation Research and Training Inst., Dehra Dun (India).
G. Singh, P. N. Singh, and L. S. Bhushan.
Agricultural Water Management, Vol 3, No 2, p 107-114, 1980. 4 Fig, 3 Tab, 11 Ref.

Descriptors: *Irrigation practices, *Fertilizers, *Crop yield, Irrigation water, Soil water, *Wheat, Triticum aestivum, Available water, Nitrogen, Field tests, India.

A three year field investigation was carried out in Northern India to examine the effects of variable fertilization and irrigation scheduling on the yield of wheat (Triticum aestivum L.). Irrigation was scheduled according to cumulative pan evaporation, with irrigations given at 25, 50, and 75% available water in the top 60 cm soil profile. Fertilizer was applied at rates of 0, 60, and 120 kg/ha nitrogen. Wheat yield was significantly affected by nitrogen fertilization and irrigation water level. Maximum yield occurred with 120 kg/ha nitrogen addition and with irrigation at 50% available soil water. Irrigation at 50% available soil water resulted in the greatest yield/cm of water use by the crop, while consumptive use of water was at a maximum when irrigation was applied at 75% available soil water. (Geiger-FRC)
W81-04963

**YIELD RESPONSE OF A SEMI-DWARF WHEAT VARIETY TO IRRIGATION OF A CALCAREOUS BROWN FLOOD PLAIN SOIL OF BANGLADESH,**
Institute of Nuclear Agriculture, Mymensingh (Bangladesh).
S. M. Rahmn, S. U. Talukdar, A. K. Kaul, and M. R. Biswas.
Agricultural Water Management, Vol 3, No 3, p 217-225, 1980/1981. 2 Fig, 3 Tab, 13 Ref.

Descriptors: *Irrigation efficiency, *Crop yield, *Wheat, Irrigation requirements, *Bangladesh, Soil water.

Since wheat is a new crop in most of Bangladesh, farmers have not yet learned the optimum time for irrigation nor the proper amount of water to use on this crop. This study was designed to develop an irrigation schedule for wheat in relation to soil water depletion and to evaluate the effects of irrigation at critical growth stages on crop yield and water use efficiency. Field studies were conducted on a calcareous brown flood plain soil and used a randomized block design experiment with eight irrigation treatments applied at critical growth stages. The yield of the semi-dwarf, high yielding wheat variety was highest, and the irrigation efficiency at the maximum, when two irrigations totalling 9.5 centimeters were applied at tillering and booting stages. No additional increase in yield resulted from a third irrigation. The soil water content deficit from the field capacity level was used to determine the quantity of irrigation water applied. The lowest grain yields were obtained in treatments consisting of no irrigation or only one irrigation at the grain-filling stage. The various irrigation treatments resulted in yield increases over no irrigation ranging from 21 to 92 percent. The depletion of soil water was found to increase as the amount of irrigation water increased. The study results indicate that the percent yield levels of wheat in Bangladesh can easily be increased by 50 to 100 percent by irrigating with only one-third to one-half of the water currently being used, provided that it is scheduled and managed efficiently. (Carroll-FRC)
W81-04964

**MAKING PERU'S DESERTS BLOOM.**
For primary bibliographic entry see Field 8A.
W81-04990

# 4. WATER QUANTITY MANAGEMENT AND CONTROL

## 4A. Control Of Water On The Surface

**OPTIMAL MIX OF ADJUSTMENTS TO FLOODS,**
Purdue Univ., Lafayette, IN. School of Industrial Design.
T. L. Morin, W. L. Meier, Jr., and K. S. Nagaraj.
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-240533, Price codes: A06 in paper copy, A01 in microfiche.
Purdue University Water Resources Research Center Technical Report No 139, June, 1981. 96 p, 4 Fig, 1 Tab, 119 Ref, 2 Append. OWRT B-109-IND(1).

Descriptors: *Flood damage, *Flood plain management, *Dynamic programming, *Flood control, Flood plain zoning, Flood proofing, Flood insurance, Reservoirs, Levees, Flood-control storage, Optimum development plans.

## Group 4A—Control Of Water On The Surface

There is an interest in developing a proceduring for evaluating the 'optimal' mix of structural and nonstructural measures for the mitigation of flood damages. However, determining this 'optimal' mix of adjustments is very difficult as a consequence of both the interdependence between the structural and nonstructural measures and the multitude of feasible combinations of structural and nonstructural measures which must be considered over time and space. The report addresses the issue of developing a general methodology for the solution of the optimal mix of adjustment problem. It is recognized that the overall problems has an underlying sequencing nature which can be exploited in order to use a dynamic programming solution approach which bears distinct similarities to the sequencing approaches used in electric generation planning problems. Algorithmic details and computational refinements are also discussed. In particular, an efficient approach is developed for modifying the exact algorithm so as to provide solutions of any desired degree of optimality with reasonable computational effort using some newly developed results on a posteriori analysis. Data requirements and implementation details are also discussed and details of an application to a real-world problem are given.
W81-04659

**URBAN STORMWATER MANAGEMENT AND TECHNOLOGY: CASE HISTORIES,**
Metcalf and Eddy, Inc., Palo Alto, CA.
W. G. Lynard, E. J. Finnemore, J. A. Loop, and R. M. Finn.
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-107153, Price codes: A16 in paper copy, A01 in microfiche. Environmental Protection Agency Report EPA-600/8-80-035, August, 1980. 354 p, 121 Fig, 115 Tab, 161 Ref.

Descriptors: *Storm runoff, *Urban runoff, *Combined sewer overflows, *Water storage, *Wastewater treatment, Design criteria, Costs, Environmental effects, Erosion control, Flood control, Urban areas, Social aspects, Economic aspects.

This report is the third in a series on urban stormwater and combined sewer overflow management. It presents 12 case histories representing most promising approaches to stormwater control. The case histories were developed by evaluating completed and operational facilities or ongoing demonstration projects that have significant information value for future guidance. Essential elements of the case history evaluations cover approch methodology, design considerations, costs, effectiveness, and environmental and socioeconomic impacts. Eight of the case histories assess Best Management Practices (BMPs) and expand the data base on source control methodology, focusing principally on planning and storage alternatives. Special considerations are given to flood and erosion control measures also having a dual benefit of stormwater control. The project sites evaluated are Bellevue, Washington; Montgomery County, Maryland; Lake Tahoe, California; The Woodlands, Texas; Orange County, Florida; San Jose, California; Middlesex County, Connecticut; and Boulder, Colorado. The remaining four case histories evaluate the control of combined sewage overflows and document a systems approach in applying unit process alternatives. The effectiveness and unit costs of storage and treatment processes are presented, together with evaluations of areawide and systemwide integration of these technologies. Storage, the key element of an integrated approach, can involve storage/wet-weather treatment or storage/dry-weather treatment, or both. The project sites are Seattle, Washington; Saginaw, Michigan; Mount Clemens, Michigan; and Lancaster, Pennsylvania.
*W81-04711*

***STREAM MAINTENANCE TO REDUCE FLOODING,***
Decatur City Engineer, IL.
R. W. Hogue.
Public Works, Vol 112, No 4, p 44-45, April, 1981. 3 Fig.

Descriptors: *Flood control, *Channel improvement, Flood protection, Floodproofing, Headwater control, Flooding, Floods, Annual floods, Stream improvement, Sangamon River, *Decatur, Illinois.

Decatur, Illinois, frequently experiences flooding conditions in the spring. The city is located on the Sangamon River, which has numerous tributary creeks and streams. A preliminary study was made of the two creeks, which determined that both contained massive blockages caused by both downed trees and various manmade structures. The numerous dams created over the years in each creek drastically increased the flood profile. By removing the heavy concentrations of debris from the channel, by clearing stream channels of all trees which could impede the flow, and by removing manmade obstacles such as aerial sewer crossings, abandoned bridges, fences, and inadequate culverts, it was felt that the flood profile would be significantly lowered. While the efforts have proved successful for the present, continued maintenance of the streams is essential. (Baker-FRC)
W81-04832

**THE IMPACT OF SURFACE MINE RECLAMATION ON HEADWATER STREAMS IN SOUTHWEST VIRGINIA,**
Arizona Univ., Tucson. School of Renewable Natural Resources.
W. J. Matter, and J. J. Ney.
Hydrobiologia, Vol 78, No 1, p 63-71, 1981. 1 Fig, 5 Tab, 36 Ref.

Descriptors: *Strip mines, *Land reclamation, *Stream pollution, Sedimentation, Erosion, Water pollution effects, Fish, Benthic fauna, Coal mines, Water quality, Invertebrates.

Physicochemical characteristics and the state of aquatic biota of streams in strip mining impacted areas reclaimed by soil grading and seeding with Sericea Lespedeza 4-7 years previously were closer to those of streams in mining areas abandoned without reclamation than to those in a non-impacted (reference) stream. Data is presented in the following order: parameter, reference stream, 2 streams in a land reclaimed area, and 2 streams in an abandoned unreclaimed area. Mean sulfate (mg per liter) 8, 307 and 185, 271 and 451; mean hardness (mg per liter) 28, 513 and 296, 333 and 538; mean alkalinity (mg per liter) 13, 29 and 22, 28 and 0; mean benthic invertebrate abundance (number per 0.26 sq meter) 859, 298 and 367, 173 and 15; % ephemeroptera 26.5, 7.6 and 53.6, 4.4 and 0; % coleoptera, 23.2, 0.2 and 1.0, 0.2 and 0; % diptera 19.8, 46.8 and 19.1, 70.0 and 97.1; fish species 7, 4 and 4, 1 and 0; fish biomass (live weight per 50 sq meters) 318, 43 and 19, 112 and 0. The reference stream also had higher pH (7.18), higher mean discharge (1.55 cu meters per min), and lower mean suspended solids (12.64 mg per liter, dry weight) than the 2 streams in reclaimed areas: 6.54 and 6.53 pH, 0.75 and 0.99 stream discharge, and 31.97 and 23.31 suspended solids. The major factor in limiting aquatic biota recovery appeared to be continued sedimentation from unvegetated spots and haul roads. Further improvements in reclamation procedures must be considered. (Cassar-FRC)
W81-04901

***REASSESSMENT OF PLANT SUCCESSION ON SPOIL HEAPS ALONG THE BORO RIVER, OKAVANGO DELTA, BOTSWANA,***
*Rhodes Univ., Grahamstown (South Africa).* Dept. of Plant Sciences.
For primary bibliographic entry see Field 2E.
W81-04995

## 4B. Groundwater Management

**INVESTIGATION OF ARTIFICIAL RECHARGE OF AQUIFERS IN NEBRASKA,**
Geological Survey, Lincoln, NE. Water Resources Div.
*W. F. Lichtler, D. I. Stannard, and E. Kouma.*
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-207094, Price codes: A06 in paper copy, A01 in microfiche. Geological Survey Water-Resources Investigations 80-93, 1980. 112 p, 41 Fig, 8 Tab, 20 Ref.

Descriptors: *Artificial recharge, *Groundwater recharge, *Aquifers, Water spreading, Irrigation, Water level, Wells, Water quality, Chemical analysis, Water management, *Nebraska, Water-level declines.

Progressive declines of ground-water levels in some areas of Nebraska prompted this investigation into the technical feasibility of recharging aquifers through wells, impoundments, pits, and canals. Information gained from a literature search and from preliminary tests was used to design several artificial-recharge experiments in Nebraska from 1977 to 1979. In well experiments, 0.46 billion gallons of water from an aquifer recharged by the Platte River was transported by pipeline and injected through a well into a sand and gravel aquifer near Aurora. Recharge was at about 730 gallons per minute during tests of 6- and 8-months duration. No evidence of clogging of the aquifer due to chemical reactions, air entrainment, or bacteria was detected in either test. In the 6-month test, evidence of clogging due to fine sediment in the recharge water was detected; however, analysis of this test indicated that recharge could have continued for several years before rehabilitation would have become necessary. Results of the 8-month test confirmed results of the earlier test until casing failure in the supply well and subsequent sediment deposition in the recharge well caused rapid water-level rise in the recharge well. In surface-spreading experiments, maximum infiltration rates from 24-foot-diameter ring infiltrometers near Aurora and Tryon were 0.4 and 11 feet per day, respectively. Results indicate that large-scale surface spreading is feasible only where low-permeability layers are absent in the subsurface. Infiltration rates from reuse pits ranged from 0.01 to 1.6 feet per day, indicating highly variable subsurface permeability. Flow measurements in an irrigation canal near Farwell indicate an infiltration rate of 0.37 feet per day. (USGS)
W81-04670

**THE USE OF A NUMERICAL MOEL IN THE MANAGEMENT OF THE CHALK AQUIFER *IN THE UPPER THAMES BASIN,***
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 2F.
W81-04970

## 4C. Effects On Water Of Man's Non-Water Activities

**AN APPROACH TO WATER RESOURCES EVALUATION OF NON-POINT SILVICULTURAL SOURCES, (A PROCEDURAL HANDBOOK).**
Forest Service, Washington, DC.
For primary bibliographic entry see Field 5B.
W81-04718

**URBAN RUNOFF QUALITY IN FINLAND AND ITS DEPENDENCE ON SOME HYDROLOGICAL PARAMETERS,**
Helsinki Univ. of Technology, Espoo (Finland). Water Engineering Div.
M. J. Melanen, and R. H. Laukkanen.
*Water Science and Technology, Vol 13, No 2, p Tor 1073-1083, 1981. 1 Fig, 9 Tab, 4 Ref.*

*Descriptors: *Urban runoff, *Hydrology, Storm runoff, *Finland, Climates, Weather, Catchment area, Water quality.*

This paper reports some conclusions drawn on experiments and records kept by the Finnish Urban Storm Water Project over the years 1977-1978. One of the main objectives of the study was to investigate variations of urban storm water quality due to different climatic and weather conditions and different land uses and other catchment related factors. It was concluded that in general, parametric testing can be applied in the statistical analysis

of urban runoff quality parameters and related hydrological variables. It was determined that urban storm runoff quality varied widely between and within different urban catchments. The average runoff quality in seven studied catchments varied considerably. No generalizations could be drawn concerning runoff quality with regard to any parameter studies. It was noted that the fraction of the variance of urban runoff quality explained by linear models of the hydrological variables is low, roughly only 30%, in this investigation, with the best explaining parameter being maximum rain intensity. (Baker-FRC)
W81-04813

**VARIED EFFECTS OF CLEAR-CUT LOGGING ON PREDATORS AND THEIR HABITAT IN SMALL STREAMS OF THE CASCADE MOUNTAINS, OREGON,**
Oregon State Univ., Corvallis. Dept. of Fisheries and Wildlife.
M. L. Murphy, and J. D. Hall.
Canadian Journal of Fisheries and Aquatic Sciences, Vol 38, No 2, p 137-145, 1981. 4 Fig, 6 Tab, 31 Ref.

Descriptors: *Logging, *Forest management, *Watershed management, Sediments, Trout, Fish, Clear-cutting, Salamanders, Amphibians, Insects, Aquatic insects, *Cascade Mountains, Oregon.

Logging impacts were investigated in the McKenzie River drainage in the western Cascades, in Oregon. Study sites were in or near the H. J. Andrews Experimental Forest, where the steep terrain ranges from 400 to 1600 m in elevation and is heavily forested with Douglas fir and western hemlock. Volcanic parent material underlies soils ranging from shallow and stony to deep clay loam. A maritime climate with about 240 cm precipitation prevails. Streams are generally steep and dominated by boulders and large woody debris. Streamflow responds quickly to storms. Streams in old-growth, undisturbed forests were sampled to characterize natural variation. Two groups of logging sites were examined: clear-cut where streams were still unshaded, and second growth sites that were heavily shaded by deciduous vegetation. The clear-cut sections generally displayed greater biomass, density and species richness of predators than old-growth forested sections. These increases were greatest in small, high gradient streams where clear-cut sites had both greater periphyton production and coarser streambed sediment than old-growth sites of similar size and gradient. In larger, lower gradient streams, the clear-cut sites showed accumulation of sediment and relatively small increases in periphyton production. Lower biomass of trout and fewer predator taxa were found in second growth logged sections at 12-35 yr after logging than in old growth sites. (Baker-FRC)
W81-04864

## 4D. Watershed Protection

**USER'S MANUAL FOR PREMINING PLANNING OF EASTERN SURFACE COAL MINING, VOLUME 5: MINE DRAINAGE MANAGEMENT AND MONITORING,**
Pennsylvania State Univ., University Park.
*For primary bibliographic entry see Field 5G.*
W81-04691

**A MAJOR WATER QUALITY PROBLEM IN ILLINOIS: SOIL MOVEMENT FROM THE WATERSHED AND CHANNEL,**
*Illinois Univ.* at Urbana-Champaign. Cooperative Extension Service.
R. D. Waker.
*In: Proceedings of a Round Table on Reclaiming* and Managing Lakes in Illinois, October 10-11, 1980. Illinois Institute of Natural Resources, Chicago, *Document No 81/06, February, 1981, p 1-3.*

Descriptors: *Illinois, *Lake sediments, *Watershed management, *Water quality control, *Erosion, Water quality data, Bank erosion, Slope degradation, Soil stability, Rainfall infiltration, Rainfall-runoff relationships, Soil conservation.

The vast majority of soil erosion in Illinois occurs as water erosion. Four conditions that may cause erosion are: (1) bare soil; (2) enough energy to detach particles from the soil mass; (3) greater amounts of water on the soil surface than can be absorbed; and (4) sloping surfaces that result in runoff. When flowing water reaches a stream, it exerts energy depending on the amount of water the stream is carrying and the rate of stream flow. Soil particles may be detached from the stream bank, or sediment may be deposited along the stream. The Universal Soil Loss Equation can provide accurate estimates (+ over - 20%) of soil erosion. Estimates of sediment reaching lakes is less reliable. Sediment in a lake comes from the lake's watershed. Soil conservation practices have been developed to reduce soil erosion in the watershed; these practices have two factors in common: (1) providing soil cover, such as for protection from raindrops; and (2) slowing water flow so that it does not gain enough velocity to detach soil particles. The recent Section 208 study shows excessive soil erosion on 39%, or nearly 10 million acres, of Illinois' cropland as a result of the demand for feed grains and extensive row crop production. The Illinois Department of Agriculture has developed guidelines for erosion standards and has given the districts two years from April 1980 to adopt them. A state-funded cost-sharing program to encourage conservation tillage was started this year, and, it is hoped that 25% of the state's rolling land can be controlled with this procedure. (Atkins-Omniplan)
W81-04727

**CONTROLLING SEDIMENT BY WATERSHED MANAGEMENT TECHNIQUES,**
Soil Conservation Service, Champaign, IL.
H. Sundmacker.
*In:* Proceedings of a Round Table on Reclaiming and Managing Lakes in Illinois, October 10-11, 1980. Illinois Institute of Natural Resources, Chicago, Document No 81/06, February, 1981, p 77-80.

Descriptors: *Soil conservation, *Erosion, *Contour terracing, *Slope degradation, *Soil stability, Construction material.

Sediment damage to lakes is often a result of soil loss from cropland. Conservation tillage has proven to be a very effective technique to control erosion. However, for conservation tillage to be effective, crop residues must be on the surface after planting. Thirty-five percent of Illinois' erosive rainfall occurs from April 15 to July 1, between planting time and the development of a crop canopy. Crop residues intercept raindrops before they hit the soil surface and dissipate much of their energy. Two dominant conservation tillage systems are used in Illinois: the chisel flow and the no-till system. Other agricultural erosion control methods are contour farming, terracing, and grass waterways. Contour farming on slopes of 2.1 to 7.0% can result in a 50% reduction in soil loss. Terracing, particularly parallel tile outlet terraces, store runoff behind terraced ridges and slowly release the water through an inlet pipe. Grass waterways convey excess water runoff across fields to safe outlets, although grade stabilization structures are often needed to control flow velocity and, thus, erosion. Streambanks and construction sites are potential sediment producing areas. If vegetation is not feasible to stabilize the site, rock riprap can be used to provide protection. Streambank erosion can also be reduced through proper maintenance, such as by regularly removing debris. (Atkins-Omniplan)
W81-04734

**SYNTHETIC SEAWEED,**
W. L. Garrett.
*U.S. Patent No 4,221,500, 5 p, 3 Fig, 5 Ref; Official* Gazette of the United States Patent Office, Vol 998, No 2, p 561-562, September 9, 1980.

Descriptors: *Patents, *Erosion control, *Beach erosion, Water control, Sedimentation waves(Water), *Synthetic seaweed.

Synthetic seaweed for use in inhibiting coastal erosion comprises an elongate anchor with at least one sheet of flexible non-woven material. A first edge portion of the sheet is secured to the anchor so that the sheet extends outwardly from the anchor terminating at an outer boundary edge. The flexible, non-woven sheet has a series of spaced apart substantially parallel cuts extending from the outer boundary edge to but not through the first edge portion to define flexible strips integrally connected by the first edge portion of the sheet. The sheet may be buoyant with or without tabs of closed cell, low density foam affixed to the free end portions of the individual strips to enhance the buoyancy. Also, the sheet may have a specific gracity greater than water with such tabs applied to the strip to provide buoyancy. In use, the anchor rests upon the bottom of the sea and the submerged flexible strips of non-woven material extend upwardly. The strips sway in the ocean water thereby reducing currents in the surrounding water which permits accretion of suspended sand and promotes sedimentation of solid particles. (Sinha-OEIS)
W81-04743

**PREVENTION OF SHORELINE EROSION BY PHYSICAL AND STRUCTURAL METHODS,**
D. A. Niccum.
In: Proceedings of a Round Table on Reclaiming and Managing Lakes in Illinois, October 10-11, 1980. Illinois Institute of Natural Resources, Chicago, Document No 81/06, February, 1981. p 106-109, 3 Fig.

Descriptors: *Shore protection, *Erosion control, *Bank erosion, *Structural engineering, Comprehensive planning, Erosion rates, Silting, Management planning, Erosion, Sedimentation, Multiobjective planning, Zoning, Land use, Retaining walls, Abutments, Lake Sara, Effingham, *Illinois.

Lake Sara in Effingham, Illinois, is the only Midwestern lake owned and operated by a municipal water authority. Because the city's water source often ran dry, the community leaders secured legislation to permit a water authority to be formed. Lake Sara came into being in 1967. No state or federal funds were involved. The city has the right to use water from Lake Sara, but has no control over the lake; it is a reserve supply tapped only when the normal supply dries up. As a result, the lake has a constant water level, which aids greatly in shoreline protection. Another protective factor is a comprehensive plan including strict zoning requirements to prevent practices that result in silting. One-third of the shoreline is for public use, one-third is for residental use, and the remainder is used for commercial camping, swimming, a marina, a motel, and a club. All residential lots were set up in half-acre parcels to prevent problems from spetic facilities. The water authority also lowers the lake each fall to permit property lessees to build shoreline protection using steel, concrete, and wood. Shoreline protection measures include vertical concrete walls of varying heights, horizontal creosoted wood timbers riveted together to form retaining walls, and breaker walls of oil drums and planking several feet from the shore to reduce wave action. Another structure is a wall of 48-inch galvanized window wells filled with poured concrete. There is also an all-steel-sheeting dock and a steel piling wall. (Garrison-Omniplan)
W81-04754

**CONSERVATION DISTRICT LAW: CHOICES AND CHALLENGES FOR WISCONSIN'S FUTURE,**
Wisconsin Univ. - Extension, Stevens Point. Dept. of Community Affairs.
For primary bibliographic entry see Field 6E.
W81-04773

**CUMULATIVE SILVICULTURAL IMPACTS ON WATERSHEDS: A HYDROLOGIC AND REGULATORY DILEMMA,**
John Muir Inst. for Environmental Studies, Inc., Napa, CA.
R. N. Coats, and T. O. Miller.
Environmental Management, Vol 5, No 2, p 147-160, 1981. 3 Fig, 52 Ref.

Descriptors: *Logging, *Watershed management, *Hydrologic aspects, Watersheds, Forest management, Cutting management, Forest watersheds, Erosion, Water quality management, Fisheries, Regulations, Legal aspects, California.

The nature of watersheds implies that the hydrologic and erosional impacts of logging and related road-building activities may move offsite, affecting areas downslope and downstream from the operation. The extent to which this occurs is a function of the interaction of many variables, including soils, bedrock geology, vegetation, the timing and size of storm events, logging technology used, and operator performance. In areas of northwestern California, these variables combine to produce significant degradation of water quality, resulting in damage to habitats of anadromous fish. A survey of recent aerial photographs, combined with an examination of associated public records, shows that within the past decade many timber harvest operations were concentrated in a single 83 square kilometer watershed in the lower Klamath River Basin. In this case the resulting soil disturbance seems likely to result in cumulative off-site water quality degradation in the lower portion of the Basin. In California, both State and Federal laws require consideration of possible cumulative effects of multiple timber harvest operations. Despite the recent reforms that have given the State a larger role in regulating forest practices on private land, each timber harvest plan is still evaluated in isolation from other plans in the same watershed. A process of collaborative State-private watershed planning with increased input of geologic information offers the best long-term approach to the problem of assessing cumulative effects of multiple timber harvest operations. Such a reform could reasonably arise from the ongoing water quality planning process under Section 208 of the amended Federal Water Pollution Control Act. (Carroll-FRC)
W81-04885

# 5. WATER QUALITY MANAGEMENT AND PROTECTION

## 5A. Identification Of Pollutants

**INVESTIGATION OF 222RN, 226RA, AND U IN AIR AND GROUNDWATERS OF MAINE,**
Maine Univ. at Orono. Land and Water Resources Center.
C. T. Hess, S. A. Norton, W. F. Brutsaert, J. E. Lowry, and C. F. Weiffenbach.
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-238552, Price codes: A03 in paper copy, A01 in microfiche. Completion Report, June, 1981. 33 p, 19 Fig, 3 Tab, 21 Ref. OWRT-B-017-ME(1).

Descriptors: *Radionuclides, *Radium, *Uranium, *Radon, Radon in air, Radon in groundwater, Radon removal, Radon measurement, Liquid scintillation, Groundwater, Groundwater supply, Home ventillation, Water supply, Activated carbon, Diffused aeration.

Transuranium nuclides were measured in potable well water in Maine using a newly developed method. Uranium values in over 700 pCi/l and radium values up to 4 pCi/l were detected. Wrenn meters measured radon values in the air in 18 Maine houses; the values ranged from .6 to 201 pCi/l and varied with time and water usage and with humidity by a factor of 2, with low radon readings at high humidity. A theoretical model was developed to describe time variation of radon in air as a function of house ventilation rate and to normalize measured radon values to one air change/hour. Radon in air was found to vary inversely with ventilation rate and to be proportional to water radon with 6 + or - 1 x 10 to the minus 5 power pCi/l in air per one pCi/l in water. Two processes were studied for removal of radon from water. Granulated activated carbon (GAC) and diffused aeration. GAC removes radon through adsorption following the empirical Freundlich isotherm model; steady-state removal continues beyond the expected saturation point, possibly because of the radioactive decay of radon adsorbed on the column. Because of steady-state removal, granulated activated carbon has the potential for development as an economical process; diffused aeration is also considered to be economically promising. (de Coquereaumont-IPA)
W81-04654

**AN INVESTIGATION INTO HAZARDOUS PHENOLIC COMPOUNDS FROM PETROLEUM SOURCES AND URBAN RUNOFF,**
Rutgers - The State Univ., New Brunswick, NJ. Dept. of Environmental Science.
S. D. Faust, W. H. Clement, and L. A. Blades-Filmore.
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-240558, Price codes: A08 in paper copy, A01 in microfiche. Water Resources Research Institute, Rutgers Univ., Final Technical Completion Report, May, 1980, 154 p. 34 Fig, 29 Tab, 70 Ref, 1 Append. OWRT-B-071-NJ(2), 14-34-0001-9083.

Descriptors: *Aromatic compounds, *Organic compounds, *Chemical wastes, *Urban runoff, Water pollution sources, Chemicals, Industrial wastes, Suspended sediments, Hazardous materials, Bottom sediments, Oil pollution, *Delaware Estuary, *Delaware River.

An investigation was directed toward the recovery, separation, and identification of hazardous phenolic compounds in the Delaware Estuary with emphasis on urban runoff. Biodegradation, adsorption, and transport studies were conducted also. Di-, tri-, tetra-, and penta- chlorophenols were found in nearly all water and bottom and sediments. 2, 4, 6-Trichloro-phenol was the predominant phenol. Urban runoff was a significant input of chlorophenols in general and pentachlorophenol specifically. Biodegradation of 2, 4, 6-trichlorophenol was fairly rapid - 2.6 days for degradation of 12.5 ug/l at 20 degrees C. The chlorophenols were adsorbed onto bottom sediments. Extent of adsorption to a sediment by a given chlorophenol correlated positively with its organic matter content. Suspended sediments represent a major role in the transport and distribution of chlorophenols in the Delaware Estuary. (Faust-Rutgers)
W81-04660

**GROUND WATER IN THE SPRINGFIELD-SALEM PLATEAUS OF SOUTHERN MISSOURI AND NORTHERN ARKANSAS,**
Geological Survey, Rolla, MO. Water Resources Div.
For primary bibliographic entry see Field 2F.
W81-04669

**WATER-QUALITY ASSESSMENT OF THE MERCED RIVER, CALIFORNIA, IN THE 1977 WATER YEAR,**
Geological Survey, Menlo Park, CA. Water Resources Div.
For primary bibliographic entry see Field 5B.
W81-04671

**COLLECTION AND ANALYSIS OF PURGEABLE ORGANICS EMITTED FROM WASTEWATER TREATMENT PLANTS,**
Research Triangle Inst., Research Triangle Park, NC.
For primary bibliographic entry see Field 5D.
W81-04685

**PRESCRIBED PROCEDURES FOR MEASUREMENT OF RADIOACTIVITY IN DRINKING WATER,**
Environmental Monitoring and Supporting Lab., Cincinnati, OH.
H. L. Krieger, and E. L. Whittaker.
Available from the National Technical Information Service, Springfield, VA 22161 as PB80-224744, Price codes: A07 in paper copy, A01 in microfiche. Report EPA-600/4-80-032, August, 1980. 142 p, 6 Fig, 75 Ref, 6 Append.

Descriptors: *Testing procedures, *Water analysis, *Drinking water, *Radiochemical analysis, *Radioisotopes, Detection limits, Regulations, Cesium, Iodine, Radium, Strontium, Tritium, Uranium, Actinides, Alpha radiation, Beta radiation.

Appropriate radiochemical procedures have been compiled in a laboratory manual for use in the analysis of gross alpha activity, gross beta activity, cesium-134, cesium-137, iodine-131, the alpha-emitting radium isotopes, radium-226, radium-228, strontium-89, strontium-90, tritium, uranium and the actinide elements, in drinking water. These methods possess the necessary sensitivity for achieving the maximum contaminant levels recommended by the U.S. Environmental Protection Agency in its Interim Primary Drinking Water Regulations. The method capabilities and minimum detection levels have been determined by replicate testing, by an internal quality assurance program, and collaborative test studies specifically designed for these nuclides. Factors considered in selecting these procedures were procedure time, method capabilities, and reliability. (Brambley-SRC)
W81-04689

**VIRUSES, ORGANICS, AND OTHER HEALTH-RELATED CONSTITUENTS OF THE OCCUQUAN WATERSHED AND WATER-SERVICE AREA, PART II: VIRUSES,**
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Civil Engineering.
R. C. Hoehn, and C. W. Randall.
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-204950, Price codes: A07 in paper copy, A01 in microfiche. Environmental Protection Agency Report EPA-570/9-80-002, March, 1981. 136 p, 8 Fig, 24 Tab, 10 Ref, 5 Append.

Descriptors: *Drinking water, *Viruses, *Urbanization, *Water pollution, *Water treatment, Water sampling, Water analysis, Raw water, Monitoring, Urban watersheds, Wastewater pollution, *Occoquan watershed, Fairfax County, Virginia.

In 1975, a project to monitor viruses in water was begun in the Occoquan watershed and water service area of the Fairfax County Water Authority (FCWA) in Virginia. Two major objectives were: to determine the background levels of viruses in Bull Run and at the FCWA's raw-water intake as a means of assessing sewage discharge and urbanization effects; and to evaluate the capacity of conventional clarification-purification processes for removing viruses and the possible occurrence of viruses in the distribution system. During the first year of this project (Occoquan-I), finished drinking water was monitored for viruses on 22 occasions under this contract and an additional 26 times by FCWA. Recoveries of single, non-vaccine-like, avirulent poliovirus isolates were reported on four occasions, which represents an inordinately high percentage of the total samplings. This rate of recovery was significantly higher than for the untreated natural waters. During the second year (Occoquan-II) improved field techniques were instituted, a program of personnel surveillance was established, and provisions were made for comparative sampling and analysis. On one occasion a virus isolate was reported from finished water, but a rectal swab from the principal field technician was positive for virus on that day. Whereas one would expect to recover viruses quite frequently from natural, untreated waters contaminated by sewage, the number of occasions when that occurred was quite small, only six recoveries from 95 sampling events. The results appear to show no significant virus contamination of the raw water source. There were substantial, detectable virus contamination of the raw water source. There were substantial, detectable differences in the efficiencies of both the virus-concentration and virus-assay procedures employed by two laboratories following currently accepted techniques for virus recovery from drinking water. (Moore-SRC)
W81-04715

**SURVEY OF THE HUNTINGTON AND PHILADELPHIA RIVER WATER SUPPLIES FOR PURGEABLE ORGANIC CONTAMINANTS,**

Environmental Protection Agency, Annapolis, MD. Annapolis Field Office.
F. A. Dreisch, M. Gower, and T. O. Munson.
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-171043, Price codes: A02 in paper copy, A01 in microfiche. Report EPA-903/9-81-003, November, 1980. 21 p, 3 Fig, 4 Tab, 3 Ref.

Descriptors: *Chloroform, *Water pollution, *Organic compounds, *Chlorinated hydrocarbons, Carbon tetrachloride, Trichloroethylene, Halogenated hydrocarbons, Tetrachloroethylene, Trichloroethane, Toluene, Schuylkill River, Ohio River, Water supply, Raw water.

*In order to determine present baseline values for* volatile organic compounds (purgeable organics) and to determine whether the concentrations of *these chemicals indicates the occurrence of unre*ported chemical mishaps, raw river water from the Schuylkill and Ohio Rivers was analyzed for purgeable organic halogenated and non-halogenated compounds. Water samples were collected from the Ohio River at Huntington, West Virginia during the period 4 December 1978 through 29 January 1979, and from the Schuylkill River at Philadelphia, Pennsylvania during the period 27 November 1978 through 24 February 1979. The Schuylkill River water contained chloroform ranging from zero to 13.5 ppb. Eleven additional compounds occurred at < 1 ppb values. The Ohio River water contained nine identifiable compounds with all the compounds present below 1 ppb with the exception of chloroform, which ranged from zero to 3 ppb. No non-halogenated compounds were found in either river, with the exception of toluene in one Schuylkill River sample. Among the most prominent compounds found in both rivers were: chloroform, carbon tetrachloride, trichloroethylene, tetrachloroethylene, and 1,1,1-trichloroethane. Cyclical patterns can be seen which indicate some contamination whose source has yet to be determined. (Moore-SRC)
W81-04717

**APPLICATION OF HEADSPACE GAS CHROMATOGRAPHY TO THE DETERMINATION OF CHLORINATED HYDROCARBONS IN WASTE WATERS,**
Research Inst. of Petrochemistry, Novaky (Czechoslovakia).
L. Lukacovic, M. Mikulas, A. Vanko, and G. Kiss.
Journal of Chromatography, Vol 207, No 3, p 373-377, March 27, 1981. 2 Fig, 3 Tab, 10 Ref.

Descriptors: *Gas chromatography, *Chlorinated hydrocarbons, *Pollutant identification, Chromatography, Wastewater pollution, Chemical analysis, Industrial wastewaters, Trace levels, Water analysis.

Headspace gas chromatography is useful for the determination of trace amounts of substances in samples that are not suitable for direct injection into the chromatographic column. An external standard method is presented for the determination of chlorinated hydrocarbons in wastewaters at individual concentrations of 0.5 to 200 parts per million (ppm) and total contents of 2 to 600 ppm. The external standard method was used for quantitative analysis of a calibration mixture (simulated wastewater) containing seven characteristic chlorinated compounds with boiling points in the range of 31C to 140C. This mixture was also used as a model mixture for optimization of the operating conditions of the chromatographic column. The determination of the substances was found to be sufficiently accurate for practical use and for evaluating the wastewater purification process. (Carroll-FRC)
W81-04771

**A RAPID BIOCHEMICAL TEST FOR MEASURING CHEMICAL TOXICITY,**
National Water Research Inst., Burlington (Ontario). Environmental Contaminants Div.
D. Liu.
Bulletin of Environmental Contamination and Toxicology, Vol 26, No 2, p 145-149, 1981. 2 Fig, 2 Tab, 13 Ref.

Descriptors: *Bioassay, *Dehydrogenase, *Toxicity, Bioindicators, Spectrophotometry, Enzymes, Bacteria, Pesticide toxicity, Arsenicals, Phenols, Toxins, Resazurin, Dyes.

A rapid and sensitive biochemical toxicity test based on the reduction of resazurin by microbial dehydrogenase is described. Mixed bacterial cultures developed from activated sludge were incubated with resazurin solution and toxicant, and percent inhibition was measured spectrophotometrically at 610 nanometers as the maximum absorbance of unreduced resazurin. The effective concentration causing 50% inhibition of the microbial dehydrogenase activity (IC50) was calculated for each toxin tested. IC50 values of *sodium arsenite, sodium arsenate, and sodium cacodylate* were 25, 100, and 2,000 ppm, respectively. The resazuring test was also found to give good *reproducibility when potassium cyanide and mercuric* chloride were examined as test toxicants at three different concentration levels over a period of eight days. The bioassay may also be used to demonstrate the toxicity of phenol, 2-chlorophenol, 2,6-dichlorophenol, 2,4,6-trichlorophenol, and pentachlorophenol to microorganisms as a function of the degree of chlorination in the phenol nucleus. Structure/function effects may also play an important role in determining the impact of a compound in the environment. When ortho-, para-, and meta-chlorophenol at three concentrations were subjected to the resazurin bioassay, differential toxicities resulted, in a manner that agreed with previously reported toxicity test data for these stereoisomers. (Geiger-FRC)
W81-04789

**SEPARATION OF TRACE ELEMENTS FROM NATURAL WATER AND WASTEWATER,**
Technische Hochschule, Darmstadt (Germany, F.R.). Fachbereich Anorganisch Chemie und Kernchemie.
K. H. Lieser, P. Burba, W. Calmano, W. Dyck, and E. Heuss.
Mikrochimica Acta, Vol 2, No 5/6, p 445-454, 1980. 1 Fig, 5 Tab, 8 Ref.

Descriptors: *Trace elements, *Separation techniques, *Water analysis, Natural waters, Wastewater, Seawater, Chemical analysis.

Methods of discrimination between different chemical forms of trace elements in natural waters and techniques for their separation are described, and results are presented for their application to Rhine water, Trace element separation methods include: separation from seawater by adsorption on activated carbon in the presence of complexing agents, separation from mineral waters by use of the chelating cellulose exchanger Hyphan, separation of actinide elements by co-precipitation with barium sulfate, and co-precipitation from wastewater with hydrous ferric oxide and with ferric phosphate. Trace elements may be present in natural waters as cationic and anionic species or neutral complexes, in colloidal form, or in suspended matter. Samples can be treated by filtration, centrifugation, and the addition of appropriate ion exchangers, as necessary. Then one of the separation methods can be applied. Ion exchange (followed by instrumental neutron-activation analysis) was used to determine the following elements in Rhine River water: Ag, As, Co, Cr, and Fe. Separation of seawater with the cellulose exchanger Hyphan found the following elements: Mn, Fe, Ni, Cu, Zn, Ta, Pb, and U. (Small-FRC)
W81-04820

**DETECTION OF MUTAGENS IN WASTEWATER, A POLLUTED RIVER AND DRINKING-WATER BY MEANS OF THE AMES SALMONELLA/MICROSOME ASSAY,**
National Inst. for Water Research, Pretoria (South Africa).
W. O. K. Graboe, R. Denkhaus, and P. G. van Rossum.
South African Journal of Science, Vol 76, No 3, p 118-123, March, 1980. 4 Fig, 2 Tab, 37 Ref.

Descriptors: *Organic compounds, *Mutagens, *Effluents, Water analysis, Potable water, Wastewater, Public health, *Pollutant identification, *Vaal River, South Africa.

Mutagens were detected at low levels in all four samples of secondary treated wastewater effluent, all three samples of Vaal River water, and two of five samples of Pretoria tap water. The Ames Salmonella/liver microsome assay test with five tester strains was applied. Highest mutagen concentrations were found in the effluent from an industrial area and in the river water. Tap water had the lowest mutagenic activity, below the health risk level. Under the extraction conditions used, only neutral organic compounds were recovered and detected. Mutagenic volatile or highly polar organic compounds, organic acids, phenols, *amines, or heavy metals were not included in this* study because they are not extracted by dichloromethane at neutral pH. Although the present water *quality does not pose a health risk, further research* and monitoring should be considered. (Cassar-FRC)
W81-04847

**ANALYSIS OF ORGANIC SUBSTANCES IN HIGHLY POLLUTED RIVER WATER BY MASS SPECTROMETRY,**
National Inst. for Environmental Studies, Ibaraki (Japan). Div. of Chemistry and Physics.
A. Yasuhara, H. Shiraishi, M. Tsuji, and T. Okuno.
Environmental Science and Technology, Vol 15, No 5, p 570-573, May, 1981. 6 Fig, 2 Tab, 20 Ref.

Descriptors: *Organic compounds, *Industrial wastes, *Pollution identification, Rivers, *Mass spectrometry, Gas chromatography.

Volatile and nonvolatile organic compounds in the *Hayashida River* were determined by gas chromatography and mass spectrometry after distillation of the sample by one of two methods, steam distillation using a Nickerson-Likens apparatus or vacuum distillation. The river, receiving wastes from leather goods manufacturers, is one of the most polluted in Japan, with COD, 365 ppm; BOD, 489; and pH, 9.2. The two methods detected different amounts of each pollutant. Therefore, the higher of the two values is reported (in ppb) in the following: ethyl acetate, 585; ethanol, 4020; 4-methyl-2-pentanone, 535; toluene, 99; 2-methylpropanol, 685; butanol, 318; 2-ethoxyethanol, 1200; tridecane, 34; 2-butoxyethanol, 5680; bis(2-dimethylaminoethyl) ether, 143; tetradecane, 298; 1,3-hexanediol, 251; 2-ethyl-1-hexanol, 111; pentadecane, 208; hexadecane, 114; heptadecane, 32; dimethylbenzyl alcohol, 119; 2-(2'-butoxy)ethanol, 240; hexylglycol monoisobutyrate, 12; 2,6-di-tert-butyl-4-methylphenol, 2095; phenol, 895; p-cresol, 204; and 1,5-di-tert-butyl-3,3-dimethylbicyclo(3.1.0)-hexan-2-one, 35. (Cassar-FRC)
W81-04886

**EFFLUENT MONITORING STEP BY STEP,**
Dow Chemical, Midland, MI.
D. R. Branson, D. N. Armentrout, W. M. Parker, C. Van Hall, and L. I. Bone.
Environmental Science and Technology, Vol 15, No 5, p 513-518, May, 1981. 2 Fig, 2 Tab, 27 Ref.

Descriptors: *Monitoring, *Effluents, Standards, *Testing procedures, Indicators, Regulators, Water quality, Pollutant identification, Water quality standards.

A compliance monitoring program for effluents, based on the tier concept, has been devised to maximize water quality and minimize monitoring costs. The program should combine frequent, inexpensive screening or indicator tests that signal poential environmental harm with more expensive, definite tests as needed. Chemical and biological tests are classified into four levels, A, B, C, and D, each increasing in required skill and equipment and in complexity. The testing scheme must be tailored to the nature of the wastewater and the size of the industry or plant. For example, it is inefficient to test for compounds not likely to be in the effluent. A typical program is outlined. It begins with a characterization of the effluent and the receiving water. After the concentration limits are set, the discharger and the permitting authority agree on a

set of indicator tests for the pollutants present. Any analytical results in excess of compliance would initiate another specified series of tests on a higher level of complexity. It is also desirable to perform certain of the more definitive tests on a planned, routine basis. (Cassar-FRC)
W81-04891

**WATER LABORATORY CERTIFICATION,**
California State Dept. of Health, Berkeley.
A. E. Greenberg, and W. J. Hausler, Jr.
Environmental Science and Technology, Vol 15, No 5, p 520-522, May, 1981. 14 Ref.

Descriptors: *Laboratories, *Testing procedures, *Water analysis, Pollutant identification, Bacterial analysis, Regulations.

The water laboratory certification programs in California and Iowa are examined to develop recommendations for further actions on the state and national levels. Several problems commonly exist in thses established programs--inaccuracies in bacteriological testing and nitrate analysis, lack of a quality assurance program, lack of a good procedure for preparing and submitting performance evaluation samples, legal and administrative problems, and a paucity of certified laboratories in certain areas. To overcome these problems, first, a mechanism for certifying all laboratories at all levels is needed. Second, adequate funding must be provided. In states unable to provide certification supervision, the EPA may possibly serve in this capacity. (Cassar-FRC)
W81-04892

**IN SITU ELECTRODEPOSITION FOR THE DETERMINATION OF LEAD AND CADMIUM IN SEA WATER,**
Australian Atomic Energy Commission Research Establishment, Lucas Heights. Analytical Chemistry Section.
G. E. Batley.
Analytica Chimica Acta, Vol 124, No 1, p 121-129, 1981. 4 Fig, 3 Tab, 21 Ref.

Descriptors: *Electrochemistry, *Lead, *Cadmium, Seawater, Heavy metals, Trace elements, Chemical analysis, In situ tests, Deposition, Anodes.

A major problem in the determination of trace concentrations of heavy metals in natural waters is the ease with which sample contamination can occur during the analysis, particularly when the techniques used require sample handling and multiple reagent additions. Techniques for the in situ electro-deposition and determination of lead and cadmium in sea water at the natural pH and in the presence of dissolved oxygen are examined. Anodic stripping voltammetry, at either the hanging mercury drop electrode or the glassy carbon thin film electrode, is suitable for the determination of labile lead and cadmium. The presence of the dissolved oxygen increases the height of the lead wave, with a shift to more negative potentials. A more versatile technique is in situ deposition of labile metals on a mercury-coated graphite tube electrode. The mercury film, deposited in the laboratory, is stable on the dried tubes, which are later used for field electrodeposition. The deposited metals are determined by electrothermal atomic absorption spectrometry. These in situ techniques provide a rapid method for pollution monitoring and for detection of metals at concentrations below those where biological effects have been observed.(Carroll-FRC)
W81-04937

**DETERMINATION OF LEAD IN SEA WATER BY ELECTROTHERMAL ATOMIC ABSORPTION SPECTROMETRY AFTER ELECTROLYTIC ACCUMULATION ON A GLASSY CARBON FURNACE.**
Bari Univ. (Italy). Inst. of Analytical Chemistry.
G. Torsi, E. Desimoni, F. Palmisano, and L. Sabbatini.
Analytica Chimica Acta, Vol 124, No 1, p 143-154, 1981. 10 Fig, 1 Tab, 43 Ref.

Descriptors: *Lead, *Seawater, *Chemical analysis, Heavy metals, *Atomic absorption spectroscopy, Spectroscopy, Electrolysis, Carbon, Trace elements, Measuring instruments.

Despite its sensitivity, electrothermal atomic absorption spectrometry has not found wide application for direct determinations of trace elements in seawater. This is largely due to the fact that the large amount of sodium chloride in the samples causes non-specific absorption. An apparatus developed by Torsi permitted both in situ electrochemical preconcentration of the analyte from a flowing solution and almost complete suppression of matrix effects because the matrix could be removed by suitable washing. This apparatus was successfully tested with respect to lead determinations in different salt solutions and for determining mercury in seawater. This investigation was designed to establish fully the potentialities of a modified and more functional version of this apparatus, using the determination of lead in seawater as the analytical problem to be solved by the technique. Lead in sea water is determined by combining in situ preconcentration of the analyte on a proper glassy carbon furnace from flowing solutions with electrothermal atomic absorption spectrometry. The effects of experimental parameters such as pH, flow rate, electrolysis current, and electrolysis time are described, and the optimum conditions for determination of lead are given. The relative standard deviation at 1.5 nanograms of lead per milliliter is + over - 1 percent, and the detection limit (twice the standard deviation of the blank) is 0.03 nanograms per milliliter. (Carroll-FRC)
W81-04938

**WATER ANALYSIS,**
Geological Suvey, Denver, CO.
M. J. Fishman, D. E. Erdmann, and T. R. Steinheimer.
Analytical Chemistry, Vol 53, No 5, p 182R-214R, 1981. 680 Ref.

Descriptors: *Literature review, *Water analysis, Chromatography, Spectrometry, Colorimetry, Chemical analysis, Photometry, Voltammetry, Electrometry, Extraction, Sample preparation, Ion exchance, Titration, Autoanalyzers, Gravimetry, Tracers, Fluorescence, Potentiometry, Polarography, *Analytical techniques.

This literature review covers the field of analytical chemistry applied to water analysis from the period of October 1978 through September 1980. During this time the number of research papers dealing with methodology for identification of organic contaminants in water has increased tremendously. Relatively extensive literature reviews of this area are cited first. Determination of alkali and alkaline earth metals has been achieved by stable isotope dilution and field desorption mass spectroscopy, energy-dispersive X-ray fluorescene, spectrophotometric or potentiometric detection, polarographic reduction, and the use of polymethyl acrylate matrix membranes. Aluminum, iron and manganese were determined by electrothermal atomic absorption, fluorimetric determinations, spectrophotometry, homogeneous catalysis and gas chromatography, electrothermal atomization, and atomic absorption spectrometry. Beryllium, cadmium, chromium, cobalt, copper, lead, nickel, silver, thallium, and zinc were determined by flameless atomic absorption spectrometry, inverse voltammetry, neutron activation, linear sweep, pulse, and differential-pulse anodic stripping voltammetry, electrothermal atomization, and graphite furnace atomic absorption spectrometry. Methods used for determinations of bismuth, gold, indium, molybdenum, rhenium, thorium, tin, tungsten, uranium, vanadium, and zirconium are presented. Studies for determining concentrations of mercury, antimony, arsenic, selenium, tellurium, boron, phosphorus, silica, sulfate, sulfite, sulfide, other sulfur compounds, halides, nitrate, nitrite, ammonia, organic nitrogen, cyanide, thiocyanate and microconstituents are also reviewed. (Baker-FRC)
W81-04939

**MERCURY AND SELENIUM CONTENT AND CHEMICAL FORM IN FISH MUSCLE,**
Rochester Univ., NY. Environmental Health Sciences Center.
C. J. Cappon, and J. C. Smith.
Archives of Environmental Contamination and Toxicology, Vol 10, No 3, p 305-319, 1981. 1 Fig, 6 Tab, 56 Ref.

Descriptors: *Fish, *Mercury, *Selenium, Pollutant identification, Chemical properties, Fate of pollutants.

Mercury and selenium were determined in 17 marine and 9 freshwater fish samples, many obtained from retail food markets. Marine samples contained between 89.4 and 2641.3 ppb methyl Hg (39-93% of total Hg), 22.4 to 634.7 ppb inorganic Hg, and 111.8 to 3276.0 ppb total Hg. Freshwater fish contained 102.8 to 2681.6 ppb methyl Hg (59-96% of total Hg), 35.9 to 133.0 ppb inorganic Hg, and 174.8 to 2806.7 ppb total Hg. More Hg was water-extractable in canned tuna (average 79%) and freshwater samples (66%) than in non-processed marine fish (average 38%). Methyl Hg was slightly more extractable than inorganic Hg for freshwater and canned fish; the reverse for unprocessed marine fish. Selenium content did not correlate with Hg content, and 14-36% was in the selenate form. Marine fish contained 167.8 to 825.4 ppb total Se; freshwater fish, 142.6 to 575.9 ppb total Se. For all species 55 to 80% of total Se was water-extractable, selenate being more extractable than selenite or selenide. (Cassar-FRC)
W81-04942

**HOT WATER EXTRACTABLE PHOSPHORUS--AN INDICATOR OF NUTRITIONAL STATUS OF PERIDINIUM CINCTUM(DINOPHYCEAE) FROM LAKE KINNERET (ISRAEL),**
Israel Oceanographic and Limnological Research Ltd., Tiberias.
D. Wynne, and T. Berman.
Journal of Phycology, Vol 16, No 1, p 41-46, 1980. 3 Fig, 4 Tab, 36 Ref.

Descriptors: *Nutrients, *Phosphorus compounds, Dinoflagellates, Peridinium, Lakes, Algae, Phosphates, Eutrophication, Water pollution effects, *Kinnert Lake, Israel.

Intracellular levels of hot water extractable phosphorus were determined in cells of the dinoflagellate Peridinium cinctum f. westii (Lemm.) Lef. in a bloom from Lake Kinneret, Israel, and in laboratory cultures. Neither total cellular P nor hot water extractable P was an unequivocal indicator of P limitation in natural Peridinium. It was clear that the organisms grew successfully with a low ambient P content, probably as a result of rapid recycling of nutrients. During the 1976 bloom P concentrations in the lake water were very low, averaging 0.004 mg per liter. Total average cellular P was 0.090 ng per cell; total hot water extractable P, 0.034 ng per cell. On march 11, the beginning of the bloom, total cellular P and hot water extractable P were higher (0.126 and 0.058 ng per cell, respectively), reaching a lower, constant value about April 4. In laboratory cultures of 5-7 mg per liter P, total cell P was about 0.20 ng per cell and hot water extractable P, 0.09 ng per cell. In cultures containing lesser amounts of P (0.02-0.05 mg per liter P) total cellular P was 0.1 ng per cell and hot water extractable P, average 0.028 ng per cell. (Cassar-FRC)
W81-04978

**INADEQUACY OF ESCHERICHIA COLI AS AN INDICATOR OF WATER POLLUTION IN A TROPICAL CLIMATE: A PRELIMINARY STUDY IN BOTSWANA,**
University of the Witwatersrand, Johannesburg (South Africa). Dept. of Genetics.
J. A. Thomson.
South African Journal of Science, Vol 77, No 1, p 44-45, January, 1981. 3 Tab, 3 Ref.

Descriptors: *Drinking water, *Bioindicators, Salmonella, Bacteria, Escherichia coli, Tropical regions, Botswana.

This study indicates that care should be taken when interpreting the results of routine examina-

tions of drinking water quality in tropical climates by the membrane filtration method. Towns in the study area have populations ranging from 7,000 to 17,000, and the water comes from boreholes which tend to be situated in outlying areas wherever possible. The increasing proximity of pit latrines makes the possibility of contamination to the boreholes greater than it was before. In performing a screening study of drinking water from six towns it was determined that, even in the absence of E. coli, some water samples contained detectable levels of presumptive salmonella. The reason for the presence of potentially harmful coliforms in the absence of E. coli in the water may be related to the survival capacities of these organisms. It was determined in one particular location that the presence of a high level (25%) of antibiotic resistant organisms in the dam water and the isolation of resistant salmonellae from standpipes may be an indication that the unsatisfactory sewerage system at the local hospital was contributing to the pollution of drinking water in the town. (Baker-FRC)
W81-04996

## 5B. Sources Of Pollution

**MICROBIAL DEGRADATION OF KEPONE IN THE CHESAPEAKE BAY,**
Maryland Univ., College Park. Dept. of Microbiology.
R. R. Colwell, L. A. McNicol, S. A. Orndorff, and J. Kelley.
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-238594, Price codes: A03 in paper copy, A01 in microfiche. Maryland Water Resources Research Center, University of Maryland Technical Report No 64, March, 1981. 33 p, 7 Fig, 5 Tab, 66 Ref. OWRT-B-034-MD(2), 14-34-0001-9074.

Descriptors: *Kepone, *Kepone-resistant bacteria, *Microbial degradation, *James River, *Chesapeake Bay, Gram negative bacteria, Gram positive bacteria, Wastewater, Aerobic bacteria, Estuarine environment, Microorganisms.

The study's aims were to identify the (1) effects of Kepone on total microflora of water and sediment and on their metabolic processes in the James River and the Chesapeake Bay; (2) kinetics of Kepone interactions based on mixed and pure sediment cultures; (3) intermediate metabolites and end products to elucidate pathways of possible microbial Kepone degradation; and (4) mechanism of resistance of Gram negative bacteria to Kepone. Data indicated the existence of stable, persistent population of Kepone-resistant bacteria in both the James River and the Chesapeake Bay. Influx of Gram negative organisms via wastewaters, runoff, etc., was found to significantly affect the total number of Kepone-resistant bacteria. The effect of Kepone on in situ microbial activity appeared best measured by the MA/cell index based on the DVC, and the activity of in situ Kepone-resistant bacteria by the Kepone DVC-based index. The effect of Kepone on Gram negative bacteria was found to be predominantly on cell membrane constituents. The severe toxic effects in membrane-bound energy metabolism seen in Gram positive bacteria are thought to be averted in Gram negative bacteria by the binding of Kepone to the cell envelope. (de Coquereaumont-IPA)
W81-04657

**THE SOURCE AND TRANSPORT OF ARSENIC IN NORTHEASTERN OHIO GROUNDWATERS,**
Case Western Reserve Univ., Cleveland, OH. Dept. of Geological Sciences.
G. Matisoff, C. J. Khourey, and J. F. Hall.
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-240525, Price codes: A04 in paper copy, A01 in microfiche. Water Resources Center, Ohio State University, Columbus, Project Completion Report No. 712435, (1981). 72 p, 17 Fig, 7 Tab, 53 Ref. OWRT-A-061-OHIO(1).

Descriptors: *Groundwater, *Arsenic compounds, *Ohio, Hydrogeology, Oxidation-reduction potential, Iron compounds, Adsorption, Groundwater recharge, Groundwater movement, Path of pollutants.

Groundwaters in the Northwest School System area of Canal Fulton, Ohio were examined for their hydrologic and chemical properties. In general, the groundwaters in the study area were interconnected by a complex system of aquifer and aquitards. Arsenic concentrations were above EPA limits in two wells, but were elevated above the background value throughout much of the area. Two major aquifer systems exist within the study area: The Sharon Sandstone of the upland areas; and the outwash sand and gravel deposits of the buried valleys. Flow is generally from the north, but local variations are caused by the Tuscarawas River Valley on the south and west of the study area. Recharge to the local aquifer system may be occurring in the central portion of the study area from the chloride-contaminated Tuscarawas River. The areal distribution of arsenic within the study area indicates that the arsenic is not sourced from the Tuscarawas Rive and gives no indication of an outside source of arsenic. Within the study area, there is no evidence for an anthropogenic source of arsenic to the groundwaters. Agricultural soils, abandoned underground coal mines, industrial impoundments to the north, and an abandoned industrial dump site within the study area were all eliminated as possible sources for the arsenic. Theoretical and laboratory studies of arsenic in these groundwaters demonstrates that it is entirely of inorganic make-up, and consists of about equal parts of arsenate and arsenite. Redox considerations suggest that arsenic is controlled by an adsorption equilibrium with ferric hydroxides, and that the reduction of the ferric hydroxides by a recent lowering of Eh and/or pH in the aquifer has liberated both iron and arsenic to solution. A high correlation between ferrous iron and total dissolved arsenic supports this model.
W81-04658

**AN INVESTIGATION INTO HAZARDOUS PHENOLIC COMPOUNDS FROM PETROLEUM SOURCES AND URBAN RUNOFF,**
Rutgers - The State Univ., New Brunswick, NJ. Dept. of Environmental Science.
For primary bibliographic entry see Field 5A.
W81-04660

**ON-SITE WASTEWATER TREATMENT PROBLEMS AND ALTERNATIVES FOR WESTERN NORTH CAROLINA,**
Western Carolina Univ., Cullowhee, NC.
S. J. Berkowitz.
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-240541, Price codes: A08 in paper copy, A01 in microfiche. Water Resources Research Institute, University of North Carolina, Raleigh, Report No 163, June, 1981. 148 p. 1 Fig, 19 Tab. OWRT-A-999-NC(54).

Descriptors: *Wastewater management, *Sewage disposal, *Septic tanks, Wastewater disposal systems, Water supply quality, Mountains, Water quality standards, Water pollution sources, Water wells, Public health, Groundwater pollution, Graham County, Haywood County, Jackson County, Macon County, *North Carolina.

This report contains the results of a project intended to help improve wastewater management in the western North Carolina mountains by developing a comprehensive picture of the region's on-site wastewater management practices and related problems, and provides a basis for evaluating the potential role alternative practices and programs could play in solving these problems. Four representative mountain counties--Graham, Haywood, Jackson, and Macon--were analyzed in detail. Approximately 100,000 people live in 40,000 homes within the four study counties. About three-quarters of these homes depend on individual wastewater disposal systems, primarily conventional septic tank systems. As of 1970, an estimated 4,000 homes (13%) had no flush toilet and 1,000 homes (3%) straight piped their raw sewage directly to the nearest stream. Approximately 2,500 homes (6%) have failing septic systems, due to poor siting, design, installation, and maintenance, and to the reduced amount of mountain land suitable for effective long-term septic system operation. There are indications that some health hazards and degraded water quality conditions in western North Carolina are attributable to on-site sewage treatment problems. An estimated 30% of the homes (about 10,000) have individual drinking water supplies that are bacteriologically contaminated. An alarming 68% to 78% of the springs sampled recently by sanitarians in the study area counties were contaminated. Many small public well systems serving trailer parks, subdivisions, second homes and seasonal developments are in fair to poor condition. Bacterial contamination was found in the majority of the streams that have been sampled in the study area counties.
W81-04661

**GROUND-WATER QUALITY ALONG THE MOJAVE RIVER NEAR BARSTOW, CALIFORNIA, 1974-79,**
Geological Survey, Menlo Park, CA. Water Resources Div.
L. A. Eccles.
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-205676, Price codes: A04 in paper copy, A01 in microfiche. Geological Survey Water-Resources Investigations 80-109, March, 1981. 63 p, 9 Fig, 2 Tab, 16 Ref.

Descriptors: *Groundwater, *Water quality, *Water pollution, Aquifers, Degradation, Wastewater disposal, Chemical analysis, *California, Barstow area, Mojave River.

The quality of ground water in the alluvium along the usually dry Mojave River near Barstow, Calif., has been monitored since 1974. Degradation has occurred as a result of wastewater discharge and irrigation return. Characteristics of the degraded ground water include concentrations of dissolved solids exceeding 1,000 milligrams per liter, odor threshold numbers exceeding 5, dissolved organic carbon exceeding 2.0 milligrams per liter, chloride exceeding 250 milligrams per liter, phenols exceeding 1 microgram per liter, and methylene blue active substances exceeding 0.20 milligram per liter. Large flows in the river during the winters of 1977-78 and 1978-79 recharged the aquifer with water from storm runoff. The ground-water-quality monitoring data showed that few changes in the concentration and distribution of chemical constituents occurred between 1974 and 1977, but between 1977 and 1979 there were overall decreases in most constituents and in odor. The monitoring data also showed that between 1977 and 1979 the degraded ground water spread and moved downgradient, whereas prior to 1977 it had been generally confined to an area between Barstow and the U.S. Marine Corps Supply Center. (USGS)
W81-04664

**WATER-QUALITY ASSESSMENT OF THE MERCED RIVER, CALIFORNIA, IN THE 1977 WATER YEAR,**
Geological Survey, Menlo Park, CA. Water Resources Div.
S. K. Sorenson, and R. J. Hoffman.
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-205668, Price codes: A03 in paper copy, A01 in microfiche. Geological Survey Water-Resources Investigations 80-75, March, 1981. 31 p, 17 Fig, 3 Tab, 19 Ref.

Descriptors: *Water quality, *Water pollution sources, *Surface waters, Sampling, Biological properties, Chemical properties, Physical properties, Nutrients, Primary productivity, *California, *Merced River, Lake McClure.

Water-quality conditions in the Merced River in California were sampled four times during the 1977 water year at 12 stations on the river and its major impoundments. Samples taken at the record or near-record low flows of the 1976-77 drought, showed that calcium and bicarbonate were the predominant ions in the water. Inflow of irrigation return water to the river caused a threefold to sevenfold increase in specific conductance between

river kilometer 42 and the farthest downstream station at kilometer 8. During the four sampling periods, the increase in total nitrogen concentrations was twofold to sixfold in that reach. Upstream of kilometer 42, the river was free of apparent water-quality degradation, with the exception of occasional increases in nitrogen and phosphorus. Measurements of primary productivity and phytoplankton in Lake McClure and at three river stations gave indications of trophic conditions in the river system. (USGS)
W81-04671

**ASSESSMENT OF ENERGY RESOURCE DEVELOPMENT IMPACT ON WATER QUALITY; THE YAMPA AND WHITE RIVER BASINS,**
Nevada Univ., Las Vegas. Dept. of Biology.
S. M. Melancon, B. C. Hess, and R. W. Thomas.
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-142192, Price codes: A09 in paper copy, A01 in microfiche. Interagency Energy-Environment Research and Development Program Report EPA-600/7-80-151, September, 1980. 182 p, 14 Fig, 44 Tab, 86 Ref, 2 Append.

Descriptors: *Resources development, *Oil shale, *Coal, *Water quality, *Monitoring, Water resources, Water pollution sources, Salinity, Nutrients, Suspended sediments, Runoff, Groundwater, Air pollution, Surface water, Strip mines, Yampa River basin, White River basin, Colorado, Utah.

The Yampa and White River Basins contain vast beds of low-sulfur, strippable coal that potentially will support a large number of coal-fired powerplants as well as some of the richest oil shale deposits in the United States. However, conversion of these energy resources into commercially usable power and fuel is expected will have considerable impact on water resources in the basins. Water quality throughout the Yampa and White River Basins is variable and strongly influenced by episodic high runoff and mineralized groundwater supplies forming the baseflow of intermittent tributaries. The parameters most likely to be affected by increased activities in the basins are elemental toxic substances, salinity, suspended sediments, and nutrients. Pollution may occur during any stage of the extraction, refining, transportation, conversion, or utilization processes. Potential contamination of groundwater supplies from in-site conversion facilities, and nonpoint pollution from sources such as stack emissions, airborne dust, and spills are of major concern in these basins. Surface water quality monitoring stations operated by the U.S. Geological Survey are abundant and generally well situated to monitor energy resource development impact. Thirteen sampling stations have been selected as having the highest sampling priority for energy monitoring throughout the basins. Priorities have also been established for water quality parameters necessary to monitor impacts from energy development. (Moore-SRC)
W81-04690

**UPTAKE, METABOLISM AND DISPOSITION OF XENOBIOTIC CHEMICALS IN FISH; WISCONSIN POWER PLANT IMPACT STUDY,**
Medical Coll. of Wisconsin, Milwaukee. Dept. of Pharmacology and Toxicology.
J. Lech, and M. Melancon.
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-135329, Price codes: A08 in paper copy, A01 in microfiche. Environmental Protection Agency Report EPA-600/3-80-082, August, 1980. 156 p, 53 Fig, 44 Tab, 131 Ref.

Descriptors: *Coal, *Powerplants, *Hazardous materials, *Trout, *Accumulation, *Metabolism, Metabolites, Biotransformation, Pollutants, Chlorinated hydrocarbons, Benzenes, Phenols, Enzymes.

Chemicals were selected which might arise from the operation of a coal-fired power plant. The uptake and elimination of carbon-14-labeled naphthalene, 2-methylnaphthalene, 1,2,4-trichlorobenzene, pentachlorophenol, and pentachloroanisole were studied. Each of these chemicals was taken up rapidly by rainbow trout. Increasing the duration of exposure to carbon-14-naphthalene or carbon-14-2-methylnaphthalene slowed the elimination of carbon-14-containing components from these fish. Activities of cytochrome P-450-related xenobiotic metabolizing enzymes in rainbow trout livers were induced. The quantities of biliary metabolites in these fish were considerably higher than those found in non-induced trout. Piperonyl butoxide reduced levels of biliary metabolites of pentachloroanisole and di-2-ethylhexyl-phthalate in trout and increased tissue levels of these chemicals. The high levels of biotransformation products of these chemicals found in fish bile during and after exposure to the chemicals in these studies support the possible use of bile sampling in pollutant-modelling programs. (Brambly-SRC)
W81-04692

**SEDIMENTS OF SOUTHERN LAKE HURON: ELEMENTAL COMPOSITION AND ACCUMULATION RATES,**
Michigan Univ., Ann Arbor. Great Lakes Research Div.
J. A. Robbins.
Available from the National Technical Information Service, Springfield, VA 22161 as PB80-226723, Price codes: A15 in paper copy, A01 in microfiche. Environmental Protection Agency Report EPA-600/3-80-080, August, 1980. 330 p, 153 Fig, 60 Tab, 82 Ref, 1 Append.

Descriptors: *Sedimentation basins, *Sedimentation rates, *Lake sediments, Elements, *Pollutants, Metals, *Heavy metals, Tin, Accumulation, Benthic fauna, Mixing, *Lake Huron.

Over a period of a year (1974-1975) nearly 100 sediment cores were taken in the Port Huron and Goderich depositional basins of southern Lake Huron. The cores were analyzed for 38 elements including most of the known or potential contaminants. The Goderich basin is five times more efficient than the Port Huron basin in collecting fine-grained materials and associated metal contaminants. Sediment mixing by benthic organisms modify the metal contaminant and radioactivity profiles. The mean sedimentation rates were 35.7 mg/sq cm/yr and 12.8 mg/sq cm/yr for the Goderich and Port Huron basins, respectively. The extent of contamination of sediments relative to natural levels was greatest for Hg, and in decreasing order, Sn, Pb, Sb, As, Cd, Zn, Ni, U, Cu, and Br. This is the first time that tin has been recorded as a contaminant in the lake, reaching a maximum concentration of 6 ppm in surface sediments. (Brambley-SRC)
W81-04696

**PROBABILITY SAMPLING TO MEASURE POLLUTION FROM RURAL LAND RUNOFF,**
North Carolina State Univ. at Raleigh.
F. J. Humenik, D. W. Hayne, M. R. Overcash, J. W. Gilliam, and A. M. Witherspoon.
Available from the National Technical Information Service, Springfield, VA 22161 as PB80-175946, Price codes: A10 in paper copy, A01 in microfiche. Environmental Protection Agency Report EPA-600/3-80-035, February, 1980. 214 p, 16 Fig, 58 Tab, 53 Ref.

Descriptors: *Runoff, *Rural aresas, *Sampling, *Flow rates, *Pollutants, *Nutrients, Algal growth, Water quality, Land use, Automation, Costs, Probabilistic process.

The feasibility of probability sampling in describing quality of rural water not affected by point sources is examined. The study site was a portion of the Chowan River Basin in Virginia and North Carolina. Flow was measured along with dissolved oxygen, temperature, conductivity, and pH. All samples were analyzed for nitrate plus nitrite nitrogen, total Kjeldahl nitrogen, total phosphate and chloride. Flow was highly variable in time and space; concentration was less so. The algal community, of many species, was usually low in biomass, with fluctuations to be explained by changes in algal input rather than by growth. Growth was limited by high flushing rates and poor light, not by nutrients. The grab sampling data revealed no clear relationships between water quality parameters and macro land-use facors. For estimating basin-wide mean values with modest budgets, grab sampling was more flexible and provided better precision of estimation than did automated sampling under the same budget. With high-budget studies (several hundred thousand 1975 dollars) this relationship may be reversed. This comparison is stated on the restrictive basis of estimating mean values; automated sampling may have other advantages with other kinds of studies. (Brambey-SRC)
W81-04702

**IMPACTS OF COAL-FIRED POWER PLANTS ON LOCAL GROUND-WATER SYSTEMS; WISCONSIN POWER PLANT IMPACT STUDY,**
Wisconsin Univ.-Madison. Inst. for Environmental Studies.
C. B. Andrews, and M. P. Anderson.
Available from the National Technical Information Service, Springfield, VA 22161 as PB80-225998, Price codes: A10 in paper copy, A01 in microfiche. Environmental Protection Agency Report EPA-600/3-80-079, August, 1980. 215 p, 26 Fig, 3 Tab, 82 Ref, 4 Append.

Descriptors: *Environmental effects, *Powerplants, *Coal, *Groundwater pollution, *Groundwater movement, *Simulation, Cooling ponds, Model studies, Water temperature, Wetlands, Construction, Thermal pollution, Vegetation, Waste dumps, Flood plains.

Quantitative techniques for simulating the impacts of a coal-fired power plant on the ground-water system of a river flood-plain wetland were developed and tested. Effects related to the construction and operation of the cooling lake and ashpit had the greatest impact. Ground-water flow system models were used to simulate ground-water flows before and after the cooling lake and ashpit were filled. The simulations and field data indicate that the cooling lake and ashpit altered local flow systems and increased ground-water discharge. Chemical changes in the ground-water system were minor. Contaminated ground water was confined to a small area near the ashpit. Thermal changes in the groundwater are a major impact of the cooling lake. Changes in water temperature and levels have altered the vegetation of the wetland, a major ground-water discharge area. Ground-water temperatures near the cooling lake were monitored. A model was used to simulate the response of subsurface temperatures to seasonal changes in a lake and air temperatures. Long-term substrate temperature changes expected in the wetland were predicted. Using ground-water temperatures to estimate flow rates was investigated. Simulated temperature patterns agreed with field data, but were sensitive to the distribution of subsurface lithologies. It is predicted that by 1987 groundwater temperatures will be increased, resulting in an increase in ground-water flow.
W81-04705

**WASTEWATER IN RECEIVING WATERS AT WATER SUPPLY ABSTRACTION POINTS,**
SCS Engineers, Inc., Redmond, WA.
M. D. Swayne, G. H. Boone, D. Bauer, and J. S. Lee.
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-111007, Price codes: A09 in paper copy, A01 in microfiche. Environmental Protection Agency Report EPA-600/2-80-044, July, 1980. 199p, 7 Fig, 15 Tab, 3 Append.

Descriptors: *Water supply, *Wastewater pollution, *Surface water, *Utilities, *Water pollution sources, Water reuse, Low flow, Municipal water, Potable water, Streamflow.

Wastewater sometimes represents a significant portion of the total flow in many receiving waters. In order to determine how much wastewater and wastewater-derived material from discharges is present in the surface water supplies of U.S. cities with populations greater than 25,000, a study was conducted using presently available data contained in computer files, reports, and other documentation. The study identified 1246 municipal water supply utilities using surface water from 194 basins

serving 525 cities. Results are tabulated to show for each utility the number of upstream wastewater discharges by type, an estimate of cumulated wastewater discharge flow, and the ratio of wastewater flow to stream or river flow. The results range from 142 utilities with no discharges identified to many utilities where the wastewater constituted a major portion of the water supply. Several utilities were determined to be using water from a source whose low flow was less than the combined upstream discharge flows. Water supplies serving cities near the bottom of large river basins were found to contain wastewater from several thousand dischargers. However, those utilities with the highest percentage of wastewater relative to supply flow were generally from small to medium sized creeks and rivers. Twenty cities with a total population of more than 7 million were determined to have surface water supplies where the upstream wastewater discharge flow was 2.3 to 16% of the average flow and 8 to 35% of low flow. (Moore-SRC)
W81-04707

**SEDIMENT-POLLUTANT RELATIONSHIPS IN RUNOFF FROM SELECTED AGRICULTURAL, SUBURBAN, AND URBAN WATERSHEDS; A STATISTICAL CORRELATION STUDY,**
Tetra Tech, Inc., Lafayette, CA.
For primary bibliographic entry see Field 2J.
W81-04710

**LONG-TERM EFFECTS OF LAND APPLICATION OF DOMESTIC WASTEWATER; MESA, ARIZONA: IRRIGATION SITE,**
Stone (Ralph) and Co., Inc., Los Angeles, CA.
For primary bibliographic entry see Field 3C.
W81-04714

**AN APPROACH TO WATER RESOURCES EVALUATION OF NON-POINT SILVICULTURAL SOURCES, (A PROCEDURAL HANDBOOK).**
Forest Service, Washington, DC.
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-119828, Price codes: $54.50 in paper copy, A01 in microfiche. Environmental Protection Agency Report EPA-600/8-80-012, August, 1980. 850 p, 264 Fig, 122 Tab, 746 Ref. EPA-IAG-D6-0660.

Descriptors: *Forest management, *Forest hydrology, *Water pollution sources, *Water pollution prevention, *Water pollution control, Nonpoint pollution sources, Stream discharge, Erosion, Sediment discharge, Dissolved oxygen, Organic matter, Nutrients, Pesticides, Fertilizers, Prediction.

This handbook provides an analysis methodology that can be used to describe and evaluate changes to the water resource resulting from non-point silvicultural activities. It covers only the pollutant generation and transport processes and does not consider the economic, social, and political aspects of pollution control. Pollutant sources considered are surface erosion, soil mass movement, nutrients and introduced chemicals (pesticides and fertilizers). This state-of-the-art approach for analysis and prediction of pollution from non-point silvicultural activities is a rational estimation procedure that is most useful in making comparative analysis of management alternatives. These comparisons are used in selecting preventive and mitigative controls and require site-specific data for the analysis. This handbook also provides quantitative techniques for estimating potential changes in streamflow, surface erosion, soil mass movement, total potential sediment discharge, and temperature. Qualitative discussions of the impacts of silvicultural activities on dissolved oxygen, organic matter, nutrients, and introduced chemicals are included. A control section provides a list of control practices that have been used effectively and a methodology for selecting mixtures of these controls for the prevention and mitigation of water resource impacts. Such mixtures are the technical basis for formulating Best Management Practices. (Brambley-SRC)
W81-04718

**THE LAND AND HAZARDOUS WASTE MANAGEMENT,**
Battelle Memorial Inst., Columbus, OH. Columbus Labs.
J. S. Pizzuto, and C. W. Townley.
Journal of Soil and Water Conservation, Vol 36, No 2, p 79-81, March/April, 1981. 2 Fig.

Descriptors: *Waste disposal, *Hazardous materials, *Landfills, Waste dumps, Toxins, Leaching, Legal aspects, Legislation, Groundwater pollution, Water pollution sources.

Unsafe disposal of hazardous wastes can contaminate groundwater. This problem is caused when hazardous wastes are dumped on open land, dumped in municipal landfills, abandoned in private landfills, or dumped into open pits and waste lakes. Wastes, particularly liquid wastes, migrate at unpredictable rates and can eventually penetrate aquifers. In some cases, water is polluted for decades. The Resource Conservation and Recovery Act (RCRA) passed in 1976 regulates the disposal of hazardous materials, and the $1.6 million superfund bill of 1980 is a legislative tool for cleaning up existing hazardous wastes sites. The Environmental Protection Agency estimates that there may be as many as 50,000 hazardous waste dumps in the US with up to 2,000 of them posing potential serious threats to public health. A secure landfill includes a protective layer of clay or plastic and is surrounded by monitoring wells. After landfill, incineration is the most common method for hazardous waste disposal. The incineration of certain kinds of hazardous wastes at sea using special incinerator ships is a method developed in Europe. Also, scientists are investigating ways microorganisms can be used to degrade toxic chemicals such as DDT or 2,4-D. (Small-FRC)
W81-04772

**RELATIONSHIPS BETWEEN SNOW COVER AND WINTER LOSSES OF DISSOLVED SUBSTANCES FROM A MOUNTAIN WATERSHED,**
Colorado Univ. at Boulder. Dept. of Environmental, Population, and Organismic Biology.
W. M. Lewis, Jr., and M. C. Grant.
Arctic and Alpine Research, Vol 12, No 1, p 11-17, February, 1980. 4 Fig, 1 Tab, 10 Ref.

Descriptors: *Snow cover, *Solute transport, *Small watersheds, Frozen ground, Nitrates, Phosphates, Soil chemistry, Path of pollutants, Frozen soils, Nutrients, Potassium, Sulfates, Calcium, Magnesium, Phosphorus compounds, Bicarbonates, Nitrogen compounds, Snowpack, Low flow, *Como Creek, Colorado, Mountain watersheds.

Dissolved materials lost from the Como Creek, Colorado, a watershed near the Continental Divide at elevation 2900 meters, were computed for the low-flow season (Fall through Winter) in different years. During the 3-year study period, June 1975 to April 1978, normal, low, and above normal snowpack conditions were observed. Soil remains unfrozen under substantial snow cover and freezes all the way to bedrock in bare areas. There were no significant differences between the years for losses of sulfate, Na(+), nitrite, ammonium, dissolved organic carbon, and dissolved organic nitrogen. Nitrate-N showed the largest annual variations, reaching about 90 micrograms per liter in stream water during the low snow season, 1976-77, and less than 25 micrograms per liter during the normal and high snow seasons. Phosphate varied considerably from 50% of the mean in the high snow season to 130% of the mean in the low snow season. Other constituents which varied significantly, but to a lesser degree, were Ca(2+), Mg(2+), K(+), dissolved organic phosphorus, bicarbonate, and H(+). The biologically active substances (nitrate, phosphate, and potassium) were most strongly affected by differences in soil frost, perhaps because some biological processes have been disrupted. A possible explanation is the physical inactivation of the nutrient uptake zone for roots. (Cassar-FRC)
W81-04790

**TRANSPORT OF DIELDRIN BETWEEN AIR AND WATER,**
Auckland Univ. (New Zealand). Dept. of Chemistry.
R. M. Slater, and D. J. Spedding.
Archives of Environmental Contamination and Toxicology, Vol 10, No 11, p 25-33, 1981. 1 Fig, 3 Tab, 19 Ref.

Descriptors: *Air pollution, *Dieldrin, *Oceans, Pesticide kinetics, Air-water interfaces, Wind velocity, Path of pollutants, Pesticides, Interfaces, Transfer, Boundaries(Surfaces).

The transfer rate of dieldrin from water to air was measured in a wind tunnel. Transfer velocities were 0.000026 cm per sec at 0 wind speed and 0.00015 cm per sec at 31.1 km per hour. Sodium chloride dissolved in the dieldrin solution had no effect on the transfer rate. Transfer of dieldrin from air to water, measured with a wetted-wall column, gave transfer velocities ranging from 0.009 cm per sec at 10 km per hour interfacial velocity to 0.052 cm per sec at 34.2 km per hour. The rate of transfer of dieldrin between air and water increased with increasing air velocity over the water surface, indicating a possible control by diffusive processes in either the air boundary layer or the water boundary layer. (Cassar-FRC)
W81-04792

**DISTRIBUTION OF VIRUSES ASSOCIATED WITH PARTICLES IN WASTEWATER,**
Florida State Univ., Tallahassee. Epidemiology Research Center.
T. W. Hejkal, F. M. Wellings, A. L. Lewis, and P. A. LaRock.
Applied and Environmental Microbiology, Vol 41, No 3, p. 628-634, March, 1981. 2 Fig, 3 Tab, 16 Ref.

Descriptors: *Viruses, *Suspended solids, *Wastewater treatment, Wastewater, Effluents, Chlorination, Path of pollutants, Adsorption, Microorganisms.

Viruses adsorbed onto solids in wastewater may be protected from inactivation by chlorine and other factors. To determine the distribution of virus among particles of different sizes, wastewater samples collected from the St. Petersburg, Florida, treatment plant were centrifuged to sediment all particles greater than 0.3 micrometers. Average percentages of viruses associated with solids larger than 0.3 micrometers were 28% in influent, 3.4% in unchlorinated effluent, and 7.7% in chlorinated effluent. These results indicated that virus associated with the original solids and the mixed liquor solids was lost during clarification, but that some protection against chlorination occurred. When a sample of virus-containing fecal suspension and a 0.22 micrometer filtrate of fecal homogenate were sonicated to disassociate virus from the particles, virus titer increased 3-fold in both suspensions, demonstrating that virus may attach to submicron particles. Thus solids-adsorbed viruses are not of major importance during the treatment process. Almost 97% of virus in unchlorinated effluent and 92% in chlorinated effluent was either free or associated with particles smaller than 0.3 micrometers. (Cassar-FRC)
W81-04795

**LETHAL COLD STRESS OF VIBRIO VULNIFICUS IN OYSTERS,**
North Carolina Univ. at Charlotte. Dept. of Biology.
J. D. Oliver.
Applied and Environmental Microbiology, Vol 41, No 3, p 710-717, March, 1981. 4 Fig, 1 Tab, 26 Ref.

Descriptors: *Oysters, *Bacteria, *Cold shock, Estuarine environment, Human diseases, Vibrio vulnificus, Vibrio parahaemolyticus, Shellfish, Pathogenic bacteria, Microorganisms, Public health, Water pollution sources.

Vibrio vulnivicus, an exceptionally virulent human pathogen found in estuarine waters, suffered cold shock in oyster homogenate held at 4C for 24 hours. The chilled cells could not repair themselves during a 60 min incubation in brain-heart infusion broth at 37C. Cells did not lose viability

when held in buffered salt solution alone at 4C or in oyster broth alone at 25C. Vibrio vulnificus inoculated onto whole oysters held on ice at 0.5C gradually died off, but at a lesser rate than in oyster broth at 4C. The bacteria did not penetrate the whole oyster tissue. Vibrio parahaemolyticus was much more viable under the above conditions, showing only a 0.5 log reduction during a 24 hour exposure at 4C in oyster homogenate. Apparently there is a lethal factor in the oyster homogenate, resistant to autoclaving, absent in the mantle fluid, unrelated to pH and selective toward Vibrio vulnificus. The standard method of homogenizing oysters for bacteriological examination may give low results for this reason. Whole oysters kept on ice are not likely to cause Vibrio vulnificus infections unless contaminated with very high levels of cells, 1 to 10 million per oysters. (Cassar-FRC)
W81-04796

**EFFECTS OF ACTIVATED CARBON AND BACTERIOSTATIC FILTERS ON MICROBIOLOGICAL QUALITY OF DRINKING WATER,**
Health and Welfare Canada, Ottawa (Ontario). Health Protection Branch.
R. S. Tobin, D. K. Smith, and J. A. Lindsay.
Applied and Environmental Microbiology, Vol 41, No 3, p 646-651, March, 1981. 1 Fig, 5 Tab, 29 Ref.

Descriptors: *Activated carbon, *Filters, *Water quality, *Bacteria, Water treatment, Path of pollutants, Coliforms, Chlorine, Microbiology, Organic matter, Water purification, *Dumping water.

Laboratory and field studies on three activated carbon filters of the type used in home kitchens and recreation vehicles showed that water quality could be adversely affected if the filter's capacity is exceeded. All filters reduced the free available chlorine from 0.20 mg per liter to below the detectable limit (0.5 mg per liter). The influent total available chlorine (0.30 mg per liter) was reduced to 0.10-0.15 mg per liter. Total organic removal was 4-33% and unrelated to flow rate. Bacterial counts in the filter effluent increased with time for the first three weeks and remained elevated for the rest of the 55-day test. Inoculating the filters with bacteria from another used filter produced effluent water with higher bacterial counts than the influent water, especially when the system was first used after overnight stagnation. Passing coliform-contaminated water through the filters and washing with normal tap water resulted in high coliform counts in the effluent from the plain filter and no detectable coliforms in the effluent from the one filter which contained silver as a bacteriostat. Since there is no readily available means of determining when the filter's capacity is exceeded, use of the filters should be considered a health hazard. (Cassar-FRC)
W81-04797

**EFFECT OF SUNLIGHT ON SURVIVAL OF INDICATOR BACTERIA IN SEAWATER,**
Hawaii Univ., Honolulu. Water Resources Research Center.
R. S. Fujioka, H. H. Hashimoto, E. B. Siwak, and R. H. R. Young.
Applied and Environmental Microbiology, Vol 41, No 3, p 690-696, March, 1981. 3 Fig, 3 Tab, 15 Ref.

Descriptors: *Bioindicators, *Solar radiation, *Bacteria, *Coliforms, Streptococcus, Raw waste water, Bactericides, Seawater, Sewage bacteria, Path of pollutants, Ultraviolet radiation, Enteric bacteria, Pathogenic bacteria, Marine microorganisms.

Natural populations of fecal coliforms (FC) and fecal streptococci (FS) in raw sewage diluted 1:1000 in sea water (a common dilution for discharge into the marine environment) or phosphate-buffered water at 24 + 2C survived for days in the absence of sunlight. However, sunlight inactivated 90% of the FC and FS within 30-90 min and 60-180 min respectively. Five hours exposure to sunlight killed virtually all bacteria in beakers covered with glass and translucent polyethylene, as well as in clear bags immersed 3.3 meters below the ocean surface. Exposure to ultraviolet light alone actually increased bacteria counts over the starting concentrations. This suggests that the visible portion of the spectrum rather than the ultraviolet is the active bactericide. Sunlight acted similarly on feces diluted 1:1000 regardless of animal source--human, chicken, or cattle, FS being more resistant than FC. Bacteria in freshwater exposed to sunlight survived much longer than in sea water; 8% of FC and 45% of FS survived the 3 hour exposure period in this case. If sewage is discharged into the sea at night, it is expected that extensive dissemination of live bacteria would occur until sunrise. Other possible factors interfering with rapid destruction of bacteria in sunlight are turbidity, foaming, and chemical composition of the water. (Cassar-FRC)
W81-04798

**FACTORS AFFECTING SALMONELLAE REPOPULATION IN COMPOSTED SLUDGES,**
Los Angeles County Sanitation Districts, Whttier. San Jose Creek Water Quality Lab.
For primary bibliographic entry see Field 5E.
W81-04799

**COAL PILE LEACHATE QUALITY,**
Oak Ridge National Lab., TN. Environmental Sciences Div.
E. C. Davis, and W. J. Boegly, Jr.
Journal of the Environmental Engineering Division, Proceedings of the American Society of Civil Engineers, Vol 107, No EE2, p 399-417, April, 1981. 7 Fig, 11 Tab, 13 Ref.

Descriptors: *Leachates, *Coal, *Storage, Rainfall, Particle size, Leaching, Sulfur, Acids, Hydrogen ion concentration.

Controlled, laboratory scale coal leaching experiments conducted to investigate several of the factors believed to influence the quality of leachate from coal storage piles are described. The type of coal being stored, the size of the coal, and the coal storage technique were evaluated using a factorial experimental design to determine the extent to which each influences leachate quality. Each of these three factors was significant in determining leachate quality. Leachate from the first few rainfalls was influenced more heavily by coal type, but over time coal particle size became important. The storage of high sulfur, acidic, eastern coals causes the most environmental concern. Leachate pH from Illinois No 6 coal ranged from 2 to 3 and contained larger amounts of dissolved metals than found in western coal leachate. Small-size coal particles required less storage space but had more surface area available for moisture contact, microbial activity, and chemical reactions. Leachate from Illinois No 6 coal and Montana Rosebud coal did not meet the standards of pH = 6-9 and total dissolved solids less than 50 mg/liter. (Small-FRC)
W81-04801

**TREATMENT EFFECTS AND POLLUTION DANGERS OF SECONDARY EFFLUENT PERCOLATION TO GROUNDWATER,**
Sewage Reclamation Department, Tel Avid (Israel).
For primary bibliographic entry see Field 5D.
W81-04807

**URBAN RUNOFF QUALITY IN FINLAND AND ITS DEPENDENCE ON SOME HYDROLOGICAL PARAMETERS,**
Helsinki Univ. of Technology, Espoo (Finland). Water Engineering Div.
For primary bibliographic entry see Field 4C.
W81-04813

**CHROMIUM SPECIES IN THE COLUMBIA RIVER AND ESTUARY,**
Bedford Inst. of Oceanography, Dartmouth (Nova Scotia). Atlantic Geoscience Centre.
R. E. Cranston, and J. W. Murray.
Limnology and Oceanography, Vol 25, No 6, p 1104-1112, November, 1980. 8 Fig, 2 Tab, 31 Ref.

Descriptors: *Chromium, *Particulate matter, *Adsorption, Sedments, Fate of pollutants, *Estuaries, Flocculation, Rivers, *Columbia River.

Chromium species and particulate Cr concentrations were determined at three depths (1, 5, and 10 meters) at five stations in the Columbia River and estuary in September, 1977. River water contained 4.4 to 5.4 nM total Cr, 62% dissolved Cr(6+), 36% particulate Cr, and 2% dissolved Cr(3+). Estuarine samples of 2.85-32.82 parts per thousand salinity varied from 2.4 to 6.3 nM total Cr, more than 40-69% particulate at the lower salinities, decreasing to 10% with dilution by seawater. Cr(3+) levels reached a peak of 20% at 10 parts per thousand salinity, and remained at less than 5% for other salinities. Chromate accounted for more than 90% of dissolved Cr and remained constant throughout the river, estuary, and adjacent ocean. It was stable over a 100 hour storage period. More than 70% of added Cr(3+) was removed by adsorption from solution in 1 hour. Flocculation experiments suggested that 18-28% of dissolved Cr could be converted to particulate Cr in the salinity range 2-20 parts per thousand. (Cassar-FRC)
W81-04817

**PATTERNS OF DISSOLVED ORGANIC CARBON IN TRANSPORT,**
Academy of Natural Sciences of Philadelphia, Avondale, PA. Stroud Water Research Center.
L. A. Kaplan, R. A. Larson, and T. L. Bott.
Limnology and Oceanography, Vol 25, No 6, p 1034-1043, November, 1980. 6 Fig, 2 Tab, 44 Ref.

Descriptors: *Organic matter, *Degradation, *Watersheds, Dissolved solids, *Organic carbon, Springs, Streams, Path of pollutants, Self-purification, Algae, Farm wastes, Small watersheds, Hydrogen ion concentrations, Forest watersheds.

Two distinct patterns of dissolved organic carbon (DOC) transport were seen in the White Clay Creek basin, souteastern Pennsylvania, under base flow conditions. In a woodland area undisturbed by man, DOC concentration approximately doubled from 600 micrograms per liter, and percentage of high molecular weight DOC (greater than 10,000 nmw), pH, color, and phenolic carbon increased with distance from the sources. Carbohydrate carbon remained constant. The seasonal DOC variations were attributed to algal and macrophyte productivity and leaf detritus decomposition. In areas disturbed by cattle, humans, or waterfowl, initially high DOC levels decreased sharply within a short distance (0.45 km), probably a result of self-purification. After this rapid decrease, DOC levels showed no detectable changes. DOC concentrations increased in summer and autumn. pH increased with distance downstream. (Cassar-FRC)
W81-04819

**THE APPLICATION OF Q-MODE FACTOR ANALYSIS TO SUSPENDED PARTICULATE MATTER STUDIES: EXAMPLES FROM THE NEW YORK BIGHT APEX,**
National Oceanic and Atmospheric Administration, Miami, FL. Atlantic Oceanographic and Meteorological Labs.
T. A. Nelsen.
Marine Geology, Vol 39, No 1/2, p 15-31, 1981. 8 Fig, 1 Tab, 17 Ref.

Descriptors: *Factor analysis, *Particulate matter, *Suspended solids, Sludge disposal, Analytical techniques, Mathematical studies, New York Bight, Water analysis, Statistical analysis, Tracking, Path of pollutants.

Suspended particulate matter (SPM) size distribution data from the New York Bight apex were analyzed by the Q-mode factor analysis, a statistical technique for rapidly evaluating large volumes of data by comparing relationships between samples based on all variables. Sources and dispersal of SPM and water masses not made obvious by conventional methods were suggested. The method was applied to several situations, including a sewage sludge dumping site, and proved useful as a method for determining the distribution of the sewage sludge. Other practical applications of this method were: movement of water masses, tracking contaminant dispersal, studying biological components of SPM, tracking blooms in seasonal studies,

establishing seasonal budgets of SPM components, and evaluating relative seasonal trends of biological vs. non-biological components of the SPM. (Cassar-FRC)
W81-04823

**NITRATE LEACHING AND IRRIGATED CORN PRODUCTION WITH ORGANIC AND INORGANIC FERTILIZERS ON SANDY SOIL,**
Illinois Univ. at Urbana-Champaign. Dept. of Agricultural Engineering.
W. D. Lembke, and M. D. Thorne.
Transactions of the ASAE, Vol 23, No 5, p 1153-1156, October/November, 1980. 2 Fig, 5 Tab, 13 Ref.

Descriptors: *Sludge disposal, *Nitrates, *Fertilizers, Soil amendments, Nitrogen compounds, Irrigation, Path of pollutants, Water pollution sources, *Illinois, Sand, Corn, Agriculture, Leaching, Crop yield.

Five fertilizer regimes were tested on irrigated corn grown in Plainfield sand in Illinois. Average corn yields (megagrams per hectare) over the four-season (1974-1977) period were no fertilizer, 1.99; low fertility, 7.49; high fertility, 11.5; sludge, 11.2; and manure, 8.72. Analysis of nitrate-N in soil water for the sludge treatment at two depths (0.3 m and 2.1 m) and during two periods (May 5-June 2 and July 12-Aug 13) showed 145 mg per liter nitrate-N at the shallow depth in the early period and 173 in the late period; 96 at the deeper depth in the early period and 260 in the late period. Original sludge nitrate-N level was 560 kg per hectare, which was readily available to the corn. Significant amounts of nitrate-N leached out of the root zone in high fertilizer, manure and sludge treatments. (Cassar-FRC)
W81-04834

**DISTRIBUTION AND PHYSIOLOGICAL DETERMINANTS OF BLUE-GREEN ALGAL NITROGEN FIXATION ALONG A THERMOGRADIENT,**
Emory Univ., Atlanta, GA. Dept. of Biology.
C. E. Wickstrom.
Journal of Phycology, Vol 16, No 3, p 436-443, 1980. 5 Fig, 4 Tab, 40 Ref.

Descriptors: *Thermal springs, *Nitrogen fixation, *Cyanophyta, Algae, Temperature, Hydrothermal studies, Streams, Hot springs, Springs, Path of pollutants, Water quality, Light intensity.

Nitrogen fixation by algal-bacterial mats was investigated in an alkaline thermal stream, Rabbit Creek, in Yellowstone National Park. Nitrogenase activity was measured by acetylene reduction. Fixation rates in September 1978 were maximum at 35C (1616 nanomoles N2 fixed per mg chlorophyll a per hour), accounting for 51.6% of the hourly fixation observed for the whole stream. No activity was observed at 60 or 65C. Other mean fixation rates (same units as above) were: 30C, 427; 40C, 979; 45C, 7; 50C, 90; and 55C, 13. In August 1978 maximal rates were 5028 at 40C. Calothrix accounted for 97% of total nitrogen fixation observed in the stream. Light intensity influenced fixation in a linear fashion from 9 to 100% of full sunlight, showing a maximum at 100%. Water quality varied over the 1380 meter length. Summer temperatures decreased from 90C at the source to 30C where the stream entered Firehole River. Other upstream to downstream values (in mg per liter) were: alkalinity (carbonate), 240-340; chloride, 305-300; nitrate, 0.40-0.25; phosphate, 1.25-2.20; silica, 850-600; and sulfate, 12.5-13.0. (Cassar-FRC)
W81-04838

**KINETIC MODEL FOR CHROMATE REDUCTION IN COOLING TOWER BLOWDOWN,**
Air Products and Chemicals, Inc., Allentown, PA.
R. G. Kunz, T. C. Hess, A. F. Yen, and A. A. Arseneaux.
Journal of the Water Pollution Control Federation, Vol 52, No 9, p 2327-2339, September, 1980. 17 Fig, 1 Tab, 29 Ref.

Descriptors: *Chromium, *Reduction, *Cooling towers, Path of pollutants, Sulfur compounds, Chemical reactions, Model studies, Mathematical models, Chemical wastes, Wastewater treatment, Dissolved oxygen, Oxygen, Kinetics.

A kinetic model represents the liquid-phase reduction of hexavalent chromium by sulfur dioxide at low pH, the simultaneous competitive reaction of dissolved oxygen with SO2, and oxygen reaeration. Both batch kinetic data for chromate reduction in cooling tower blowdown and values from the literature were used to determine model parameters. SO2 and its salts reduce hexavalent chromium to the trivalent state. The rate of reaction increases with increasing reactant concentration, increasing temperature, and decreasing pH. Dissolved oxygen competes with hexavalent Cr for SO2, and reaeration can be a problem. The model was tested in the laboratory and found to be slightly conservative compared to batch and continuous flow data. Residual hexavalent Cr is lower in a batch reactor than in a continuous stirred tank reactor of equivalent residence time. To reach a hexavalent Cr level of 0.05 mg per liter in a continuous stirred reactor, SO2 to Cr ratios of at least 10 to 1 must be used. This model can be extended to multiple reactors with multiple SO2 feed points. (Cassar-FRC)
W81-04843

**OZONE INACTIVATION OF CELL- AND FECAL-ASSOCIATED VIRUSES AND BACTERIA,**
Maine Univ. at Orono.
D. M. Foster, M. A. Emerson, C. E. Buck, D. S. Walsh, and O. J. Sproul.
Journal of the Water Pollution Control Federation, Vol 52, No 8, p 2174-2184, August, 1980. 1 Fig, 8 Tab, 17 Ref.

Descriptors: *Ozone, *Viruses, *Bacteria, *Disinfection, Turbidity, Path of pollutants, Water treatment, Coliforms, Water reuse, Microorganisms, Enteric bacteria, Wastewater treatment.

Fecal associated coliform bacteria and enteric viruses in water were protected to a small extent from ozone inactivation. However, under common disinfection practices, both associated and non-associated microorganisms were destroyed within 30 sec. Protection of fecal-associate coliforms, poliovirus (Sabin Type 1), and porcine picornavirus Type 3 (Strain ECPO-6) at 5 turbidity units was demonstrated at initial ozone concentrations of 0.096, 0.013, and 0.024 mg per liter, respectively. No protection against ozone occurred at 1 turbidity unit with fecal coliforms and poliovirus at initial ozone concentrations of 0.13-0.62 mg per liter and 0.65-2.84 mg per liter, respectively. HEp-2 cell-associated poliovirus and coxsachievirus were protected at initial ozone concentrations of 0.65-2.84 and 2.99-4.68 mg per liter, respectively. Non-associated poliovirus (2400 PFU per ml), coxsackievirus (13,000 PFU per ml), porcine picornavirus (16,000 TCID50 per ml), Escherichia coli (1.1 million MPN per 100 ml), and streptococcus fecalis (150 million CFU per 100 ml) were reduced to non-detectable levels within 10 sec at initial ozone concentrations of 0.085, 0.081, 0.220, 0.096, and 0.28 mg per liter, respectively. (Cassar-FRC)
W81-04844

**GROWTH OF A COCCOID NANOPLANKTER (EUSTIGMATOPHYCEAE) FROM THE CHEASPEAKE BAY AS INFLUENCED BY LIGHT, TEMPERATURE, SALINITY AND NITROGEN SOURCE IN FACTORIAL COMBINATION,**
Maryland Univ., College Park. Dept. of Botany.
D. E. Terlizzi, Jr., and E. P. Karlander.
Journal of Phycology, Vol 16, No 3, p 364-368, 1980. 3 Fig, 1 Tab, 33 Ref.

Descriptors: *Nitrogen compounds, *Algae, *Growth rates, Ammonium compounds, Urea, Nitrates, Light, Temperature, Salinity, Cultures, Eustigmatophyceae, Factor analysis, Culture media, Chesapeake Bay, *Culturing techniques.

Cultures of Nannochloris oculata Droop were grown in 81 combinations of light intensity (0.208, 0.708, and 1.350 mW per sq cm), temperature (15, 20, and 30C), salinity (5, 15, and 35 parts per thousand) and nitrogen source (nitrate, ammonium, and urea). Nitrogen sources were present at 300 microgram-atom N per liter. Maximal growth rate of 2.1 doublings per day occurred at 30C, 15 parts per thousand salinity, light intensity 1.350 mW per sq cm, with ammonium or urea. General trends observed were: (1) salinity optima were between 5-15% in all cases, (2) no growth occurred at 10C, and growth improved with increases in temperature to 30C, and (3) light optimum decreased with temperature decreases below the optimum. For nitrate and ammonium cultures, temperature influenced growth rate most, followed by light and salinity. For urea, temperature was most important, followed by salinity and light. Interactions among environmental variables and nitrogen sources suggest that surveys based on fixed variables alone may produce unreliable results. (Cassar-FRC)
W81-04852

**PHOSPHORUS-CADMIUM CYCLING IN NORTHEAST PACIFIC WATERS,**
Moss Landing Marine Lab., CA.
G. A. Knauer, and J. H. Martin.
Journal of Marine Research, Vol 39, No 1, p 65-76, February, 1981. 3 Fig, 4 Tab, 17 Ref.

Descriptors: *Phosphorus, *Cadmium, *Oceanography, Heavy metals, Decomposing organic matter, Organic matter, Phosphates, Pacific Ocean, Particulate matter, *Coastal waters.

The vertical distributions of dissolved and particulate cadmium and phosphate (PO4) were determined in water samples collected off the central California coast in an effort to gain understanding of cadmium and phosphate cycling in relation to organic matter. Cadmium, phosphate, and carbon were also measured in passively sinking particulates which were caught in particle interceptor traps set at depths of 35, 65, 150, 750, and 1500 meters. As expected, close relationships were observed between these elements; cadmium and phosphate concentrations in the suspended and trapped particulates decreased markedly with depth, suggesting that these elements are released as their organic carriers are destroyed. Major portions of the cadmium and phosphate were found to be very weakly associated with the trapped particulates, indicating that significant portions of the elements and compounds associated with sinking particles may be lost after the particles enter the traps. The dissolved cadmium and phosphate concentrations observed in water, together with the flux data for these elements, were used to calculate residence times for various segments of the water column. Residence times of about 250 years for the upper 750 meters for both cadmium and phosphate. Various components of the phosphate cycle acutally measured in this study, together with estimates from the literature, were combined in a schematic drawing in an attempt to depict the phosphate cycle occurring in the upper waters of the ocean. (Carroll-FRC)
W81-04859

**A STUDY OF NO3-N IN PRIVATE WATER SUPPLIES IN LINCOLN COUNTY, WASHINGTON,**
Washington State Univ., Pullman. Dept. of Bacteriology and Public Health.
J. B. Conway.
Journal of Environmental Health, Vol 43, No 5, p 257-262, March/April, 1981. 3 Fig, 1 Tab, 18 Ref.

Descriptors: *Nitrates, *Coliforms, *Well water, Domestic water, Bacteria, Chlorides, Water pollution, Regulation, Public health, *Lincoln County, Washington.

A study of twelve private wells in Lincoln County, Washington, determined that all of the wells had NO3-N levels in excess of that allowed by the Environmental Protection Agency public drinking water standard, and many also exceeded the EPA coliform standard. The wells were monitored weekly for 14 months and samples were analyzed for NO3-N, bacteria, pH, temperature, and chlor-

ides. The water from some of the wells may be a potential health hazard. Two of the wells had NO3-N levels 4 times the EPA standard, and the total coliform standard was also exceeded. No major disease problems which could be traced directly to high levels of NO3-N in the water have been reported in Lincoln County. Environmental health specialists should be involved in assuring the quality and safety of all water supplies, not just public water supplies. The cost of a monitoring program would be considerable, whether on-site testing or analyzing samples in the laboratory is used. A minimum monitoring program could include only those private wells being used by expectant mothers. (Small-FRC)
W81-04861

**A POLYCHLORINATED DIBENZOFURAN AND RELATED COMPOUNDS IN AN ESTUARINE ECOSYSTEM,**
Environmental Protection Agency, Narragansett, RI.
J. L. Lake, P. F. Rogerson, and C. B. Norwood.
Environmental Science and Technology, Vol 15, No 5, p 539-544, May, 1981. 7 Fig, 6 Tab, 16 Ref.

Descriptors: *Organic compounds, *Polyclorinated biphenyls, Pollutant identification, Mussels, Chemical wastes, Estuaries, Path of pollutants, Water pollution sources, Narragansett Bay, Rhode Island.

Trichlorodiphenyl ether, tetrachlorodiphenyl ether, and 2,4,8-trichlorodibenzofuran were identified in suspended particulate matter and in samples of mussels caged for several months at different stations in Narragansett Bay, Rhode Island. Highest total concentrations (up to 1700 ppb in mussels, <1 ppt in particulates) were found in the highly polluted upper bay, decreasing with increasing distance from the industrial area. In the lower bay, 37 km from Providence, concentrations in particulates were 20 times lower than in the upper bay. Less than 80 ppb were found in mussels 34 km from the upper bay. A potential source of the pollution is a chemical plant which manufactures 2,4,4'-trichloro-2'-hydroxydiphenyl ether. (Cassar-FRC)
W81-04889

**ROCKS, SOILS AND WATER QUALITY. RELATIONSHIPS AND IMPLICATIONS FOR EFFECTS OF ACID PRECIPITATION ON SURFACE WATER IN THE NORTHEASTERN UNITED STATES,**
Brookhaven National Lab., Upton, NY.
E. Kaplan, H. C. Thode, Jr., and A. Protas.
Environmental Science and Technology, Vol 15, No 5, p 539-544, May, 1981. 7 Fig, 6 Tab, 16 Ref.

Descriptors: *Acid rain, *Soil types, *Bedrock, *Water quality, Surface water, Water pollution effects, Rocks, Alkalinity, Hydrogen ion concentration, Geology.

Soils were more important than bedrock in determining regional sensitivities to acid precipitation. This conclusion is contrary to hypotheses advanced previously. Data on rocks, soils, land use, and water quality was collected from 283 counties in New England and the Middle Atlantic States. Four of the nine possible soil classes were found: alfisols, inceptisols, spodosols, and ultisols. Bedrocks were classified as intrusive igneous, metamorphic, consolidated sedimentary, and unconsolidated and weakly consolidated sedimentary. The area of concern contained no extrusive igneous rocks. Cluster analysis was applied to the rock and soil data. Path analysis produced two models, one relating rock types to soil classes, and the second, the effect of rocks and soils on water quality. This showed that the only rock which contributed to water quality was consolidated sedimentary. The presence of spodosols, ultisols, and inceptisols indicated surface waters of lower alkalinity and greater susceptibility to acidification from acid rain. Areas with larger percentages of alfisols have greater resistance to the effects of acid precipitation. (Cassar-FRC)
W81-04890

**SECOND-ORDER MODEL TO PREDICT MICROBIAL DEGRADATION OF ORGANIC COMPOUNDS IN NATURAL WATERS,**
Environmental Research Lab., Athens, GA.
D. F. Paris, W. C. Steen, G. L. Baughman, and J. T. Barnett, Jr.
Applied and Environmental Microbiology, Vol 41, No 3, p 603-609, March, 1981. 4 Fig, 4 Tab, 17 Ref.

Descriptors: *Microbial degradation, *Malathion, *Chlorpropham, 2,4-D, Pesticide kinetics, Kinetics, Bacteria, Herbicides, Organic compounds, Path of pollutants, Degradation, Biodegradation.

Microbial degradation of three pesticides that undergo hydrolytic degradation was studied in waters from 40 sites in 18 states. The rates of degradation conformed to second-order kinetics; that is, the rates were proportional to both bacterial and xenobiotic concentrations. Rate constants for organic compounds degradation in natural waters were as follows: 2,4-dichlorophenoxyacetic acid, butoxyethyl ester, 1.5 to 12.0 times 10 to the minus 10th power; malathion, 2.5 to 6.3 times 10 to the minus 11th power; and chlorpropham, 1.3 to 4.9 times 10 to the minus 14th power. Half lives for each compound were 2.6 hours, 2,4-DBE; 32 hours, malathion; and 53,000 hours, chlorpropham. (Cassar-FRC)
W81-04896

**PCBS AND WASTEPAPER,**
New York State Dept. of Environmental Conservation, Albany.
K. J. Walter, and J. J. Zambrano.
Industrial Wastes, Vol 27, No 2, p 12-15, March/April, 1981. 3 Fig, 2 Tab, 2 Ref.

Descriptors: *Polychlorinated biphenyls. *Waste paper, *Recycling, Water pollution sources, Wastewater pollution, Industrial wastes, Water quality, Public health.

A one year survey of polychlorinated biphenyls (PBCs) in paper recycling mill treated wastewater was performed. Samples were collected and analyzed once a month for 19 mills which processed some percentage of recycled paper and had wastewater discharge permits. From 1957 to 1971, PBCs were used in the manufacture of carbonless copy paper. Paper made from recycled PBC-contaminated paper may be recycled again and again, causing the current concern about contamination. Total New York state recycled paper use is approximately 1800 tons/day. Eighty-one percent of the tests from all mills had a value of less than 1 ppb PCB. There was an average concentration of 0.61 ppb PCB at mills with wastewater treatment systems. The total discharged from the 18 mills surveyed was 43 gr/day or 14 kilograms per year. These results did not consider possible PCB levels in the groundwater. One of the mills that had no wastewater treatment discharged 2.6 ppb PCBs. PCB wastewater treatment was judged not practical for plants with primary or secondary treatment. (Small-FRC)
W81-04900

**UPTAKE AND DEPURATION OF PETROLEUM HYDROCARBONS BY CRAYFISH,**
Fish and Wildlife Service, Laurel, MD. Patuxent Wildlife Research Center.
For primary bibliographic entry see Field 5C.
W81-04940

**MERCURY AND SELENIUM CONTENT AND CHEMICAL FORM IN FISH MUSCLE,**
Rochester Univ., NY. Environmental Health Sciences Center.
For primary bibliographic entry see Field 5A.
W81-04942

**OXIDATIVE POWER OF MN(IV AND FE(III) OXIDES WITH RESPECT TO AS(III) IN TERRESTRIAL AND AQUATIC ENVIRONMENTS,**
Saskatchawan Univ., Saskatoon. Dept. of Soil Science.
D. W. Oscarson, P. M. Huang, C. Defosse, and A. Herbillion.
Nature, Vol 291, No 5810, p 50-51, May 7, 1981. 2 Tab, 15 Ref.

Descriptors: *Oxidation, *Arsenic, *Bottom sediments, Lakes, Toxicity, *Manganese, *Iron oxides, Water pollution control, Arsenite.

The speciation and transformation of As in aquatic environments was studied. Suspended and bottom sediments can potentially detoxify As(III) by converting it to As(IV) through abiotic oxidation. The possible roles of the oxides of Mn(IV) and Fe(II) as the primary electron acceptors in the oxidation of As(III) were investigated. Mn and Fe were chosen because they readily participate in many oxidation-reduction reactions in natural environments. Laboratory tests with freshwater lake sediments found Mn(IV) oxide to be a very effective oxidant with respect to As(III). Despite thermodynamic favorability, a redox reaction between Fe(III) oxide and As(III) did not occur within 72 hr. This indicated that the kinetics of the redox reaction between As(III) and Fe(III) are relatively slow. Thus, Mn(IV) oxide may be very important in natural systems in decreasing the concentration of As(III), a highly toxic pollutant. (Small-FRC)
W81-04946

**SUPPLY OF IRON AND MANGANESE TO AN ANOXIC LAKE BASIN,**
Freshwater Biological Association, Windermere (England).
W. Davison.
Nature, Vol 290, No 5803, p 241-143, March 19, 1981. 1 Fig, 29 Ref.

Descriptors: *Lake sediments, *Sediments, Metals, *Iron, *Manganese, Anaerobic conditions, Path of pollutants, Hypolimnion, Stratification, Sediment-water interface, Seasonal.

Concentration-depth profiles for iron and manganese were measured in seasonally anoxic Esthwaite Water at monthly intervals during 1980 as part of a continuing study on geochemical cycling of Fe and Mn in Lakes. No polarographically measurable Fe(2+) was detectable until early July, but total iron released from the sediment gradually increased in the water column as the summer progressed. Near the end of the season dissolution of particulate iron falling through the water column became significant. Calculations show that 2.20 tons of Fe and 0.027 tons of Mn were sediment-derived. Dissolution of particles falling through the water column accounted for 89-90% of the Mn flux. (Cassar-FRC)
W81-04947

**POLLUTION LOADING TO THE GREAT LAKES FROM MUNICIPAL SOURCES IN ONTARIO,**
Nova Scotia Technical Coll., Halifax. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2H.
W81-04953

**DDT CONTAMINATION AT WHEELER NATIONAL WILDLIFE REFUGE,**
Fish and Wildlife Service, Laurel, MD. Patuxent Wildlife Research Center.
T. J. O'Shea, W. J. Fleming, III, and E. Cromartie.
Science, Vol 209, No 4455, p 509-510, July, 1980. 1 Tab, 16 Ref.

Descriptors: *Industrial effluents, *Pesticides, *DDT, River, Estuaries, Wildlife, Wildlife habitats, Organic contaminants, Pollutants.

From 1947-1970 DDT was manufactured on a site leased from the US Army at Redstone Arsenal, Alabama. A ditch carrying effluent from the factory ran directly into Wheeler National Wildlife Refuge, where it joined Huntsville Spring Branch, a tributary to the Tennessee River about 1 km from the plant site. In the 1960's attempts were made to contain the effluent by dumping it in holding ponds or hauling it to landfills but the amount of DDT isomers and metabolites currently present in the sediments on Huntsville Spring Branch without the wildlife refuge has been esti-

mated as high as 4,000,000 kg. In February of 1979 fist-sized chunks of crystalline material was collected from the ground near the plant site - the material was 21% DDT. Nearly 9 years after DDT production at Redstone had ceased, mallard ducks, crows, cottontail rabbits, and swamp rabbits were collected and examined for DDT. Impaired reproduction on breeding grounds by water fowl wintering at Wheeler National Wildlife Refuge is highly likely. Earthworm concentrations of 224 ppm DDT have been reported. (Baker-FRC)
W81-04962

**EXPERIMENTAL ASSESSMENT OF POLLUTANT MIGRATION IN THE UNSATURATED ZONE OF THE LOWER GREENSAND,**
Institute of Geological Sciences, Harwell (England). Environmental Protection Unit.
C. A. M. Ross.
Quarterly Journal of Engineering Geology, Vol 13, No 3, p 177-187, 1980. 2 Fig, 8 Tab, 26 Ref.

Descriptors: *Landifills, *Leachates, *Industrial wastes, Aeration zone, Lysimeters, Heavy metals, Organic compounds, Clays, Metals, Path of pollutants, Fate of pollutants, Biodegradation, Microbial degradation, Carbonate rocks, Chemical reactions, Anions, Chemical wastes, Lower Greenland, Uffington area, United Kingdom.

Synthetic leachates were applied to the Lower Greensand near Uffington, Oxfordshire, to study the fate and migration of pollutants in the unsaturated zone. Biodegradation was the primary mechanism for attenuation of organic compounds and inorganic anions. None of the organic leachate (containing aniline, phenol, dichlorophenol, acetate, Na, Rb, xylene, trichloroethylene, and dichloroethane) was detected at 250 mm below the lysimeter surface during a 2 year irrigation period. Phosphate and ammonia in the 'anionic' leachate did not exceed 3 mg per liter concentration at 250 mm below the lysimeter surface; acetate remained below 20 mg per liter. Nitrate reached the base of the lysimeter at about half the input concentration of 100 mg per liter. Chloride and sulfate were not attenuated. Heavy metals migration was limited by interactions with the soil, especially uptake by sesquioxides and clays. The Lower Greensand was capable of attenuating the following metals in the 'heavy metal' leachate (grams per cu meter): Ni, 290; Cd, 450; Zn, 700; Cr, 1100; Cu, 1200; and Pb, 1600. The most mobile metal, Ni, is unlikely to migrate further than 0.5 meters in 40 years. (Cassar-FRC)
W81-04971

**CONTAMINATION OF A CHALK AQUIFER BY MINE DRAINAGE AT TILMANSTONE, EAST KENT, U.K.,**
Southern Water Autority, Worthing (England).
H. G. Headworth, . Puri, and B. H. Rampling.
Quarterly Journal of Engineering Geology, Vol 13, No 2, p 105-117, 1980. 9 Fig, 13 Ref.

Descriptors: *Aquifers, *Mine drainage, *Saline water, Chalk aquifer, Path of pollutants, Water pollution sources, Chlorides, Mathematical models, Model studies, Observation wells, Coal mining, Groundwater, East Kent, United Kingdom.

Pumping saline groundwater (200-5000 mg per liter chloride) from mines in the Kent Coalfield has caused the top 40-50 meters of the Chalk Aquifer in East Kent, United Kingdom, to be contaminated over a 27 sq km area. It is estimated that only 15% of the 318,000 tons of chloride discharged into surface lagoons in the period 1907-1974 has been removed by two streams. The highly fisured zone 30-40 meters deep is highly saline; the intermediate zone has lower chloride concentrations with a few high concentration peaks along some well-developed fissures; the deepest zone, having negligible groundwater flow, is relatively uncontaminated. Although salinity problems were noticeable as early as 1930, no serious effort was made to stop further pollution until 1974, when a pipeline was built to carry draniage water directly to the sea. Observation boreholes, surface resistivity studies, salinity profiles, 15 months pumping from a production well, and application of a mathematicalmodel showed that 87% of the chlorides discharged into the aquifer are still present. This is expected to decrease to 30% by the year 2008. In 30 years chloride concentration will decrease to 200 mg per lier. The two streams draining the area will reach a peak of 400 mg per liter chloride in 1993. Attempts at artificial rehabilitation by pumping would produce negligible benefits. (Cassar-FRC)
W81-04972

## 5C. Effects Of Pollution

**UPTAKE, METABOLISM AND DISPOSITION OF XENOBIOTIC CHEMICALS IN FISH; WISCONSIN POWER PLANT IMPACT STUDY,**
Medical Coll. of Wisconsin, Milwaukee. Dept. of Pharmacology and Toxicology.
For primary bibliographic entry see Field 5B.
W81-04692

**ZOOPLANKTON GRAZING AND POPULATION DYNAMICS RELATIVE TO WATER QUALITY IN SOUTHERN LAKE HURON.**
State Univ. of New York at Albany. Dept. of Biological Sciences.
D. C. McNaught, M. Buzzard, D. Griesmer, and M. Kennedy.
Available from the National Technical Information Service, Springfield, VA 22161 as PB80-225709, Price codes: A07 in paper copy, A01 in microfiche. Environmental Protection Agency Report EPA-600/3-80-069, July, 1980. 142 p, 44 Fig, 34 Tab, 24 Ref, 3 Append.

Descriptors: *Zooplankton, *Phytoplankton, *Saginaw Bay(Michigan), *Water quality, *Biocontrol, *Population dynamics, Seasonal variation, Crustaceans, Copepods, Cyanophyta, Aquatic productivity, Primary productivity, *Lake Huron.

The seasonal and daily patterns of grazing by the crustacean zooplankton were investigated with reference to selectivity of grazing, biological control, and the abundance of crustacean zooplankton. Over a growing season the crustaceans grazed 0.3-41.9% of the standing crop of phytoplankton. Immature copepods (nauplii and copepodites) were the most effective grazers. Selective grazing by crustaceans centered on nannoplankton (22 micrometer diameter), whereby 92 to 2840% of the daily productivity was grazed by large cladocerans and immature copepods. In contrast, netplankton was harvested to a much lesser degree. Laboratory experiments reinforced this picture of selective cropping. Presently in Lake Huron such selective grazing accounts for an effective biological control over algal production; such control will be lost if these phytoplankton populations are allowed to shift to ones dominated by large blue-green algae. Populations of herbivores were also used to characterize water quality. Generally outer Saginaw Bay and most inshore waters were of lower water quality than offshore surface waters. These inshore areas also had the highest productivity of zooplankton. (Brambley-SRC)
W81-04694

**RESPONSES OF STREAM INVERTEBRATES TO AN ASHPIT EFFLUENT; WISCONSIN POWER PLANT IMPACT STUDY,**
Wisconsin Univ., Madison. Inst. for Environmental Studies.
J. J. Magnuson, A. M. Forbes, D. M. Harrell, and J. D. Schwarzmeier.
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-117947, Price codes: A08 in paper copy, A01 in microfiche. Environmental Protection Agency Report EPA-600/3-80-081, August, 1980. 165 p, 30 Fig, 34 Tab, 228 Ref, 6 Append.

Descriptors: *Coal, *Powerplants, *Water pollution effects, *Fly ash, *Effluents, *Invertebrates, Water quality, Habitats, Environmental effects, Trace elements, Sediments, Specific conductivity, Sublethal effects, Stress, Substrates, Toxicity, Crustaceans, Wisconsin, Rocky Run Creek.

Fly ash from the 527-MW coal-fired Columbia Generating Station Unit I (Columbia Co., Wisconsin) is discharged as a slurry into an adjacent ashpit. Water from the ashpit is pumped to a ditch that joins the ashpit drain and Rocky Run Creek before they reach the Wisconsin River. Habitat alterations have been noted as relatively minor changes in water quality parameters (alkalinity, hardness, pH, and turbidity), as increased amounts of some dissolved trace elements 8Cr, Ba, Al, Cd, and Cu), and as the precipitation of trace elements (Al, Ba, and Cr) into a floc that coats the stream bottoms. The ashpit drain became an unsuitable habitat for aquatic invertebrates after Columbia I began operating. The conductivity of the effluent increased in January 1977 when sodium bicarbonate was first used to increase the efficiency of the electrostatic precipitators. Since then conductivity measurements have indicated effluent concentration at distances downstream from the generating station. Rocky Run Creek is still a suitable habitat for many aquatic invertebrates, but evidence of sublethal stresses and habitat avoidance exists. The major effect of Columbia I on aquatic invertebrates is hypothesized to be continued habitat alteration and, in particular, reduced substrate quality and avoidance of unpreferred habitat. The susceptibility of early life stages of crustaceans to the ash effluent may also be important. Acute toxicity to adult forms is unimportant.
W81-04695

**PHYTOPLANKTON COMPOSITION AND ABUNDANCE IN SOUTHERN LAKE HURON,**
Michigan Univ., Ann Arbor. Great Lakes Research Div.
E. F. Stoermer, and R. G. Kreis, Jr.
Available from the National Technical Information Service, Springfield, VA 22161 as PB80-216013, Price codes: A17 in paper copy, A01 in microfiche. Environmental Protection Agency Report EPA-600/3-80-061, July, 1980. 396 p, 94 Fig, 29 Tab, 93 Ref, 2 Append.

Descriptors: *Phytoplankton, *Eutrophication, *Lake Huron, *Water pollution effects, *Nuisance algae, *Algae, Oligotrophy, Bays, Lake circulation, Nutrients, Water quality, Cyanophyta, Aphanizomenon, Spatial distribution.

Southern Lake Huron contains a diversity of phytoplankton assemblage types ranging from assemblages characteristic of oligotrophic waters to those which usually occur under highly eurtophic conditions. The offshore waters are generally characterized by oligotrophic associations and most eutrophic associations are associated with the Saginaw Bay interface waters. Under certain conditions, populations which are generated within Saginaw Bay are found mixed with offshore assemblages, apparently as a result of passive dispersal. The most widely dispersed populations include nuisance-producing blue-green algae such as Aphanizomenon flos-aquae. During the period of study, floristic modification resulting from inputs from Saginaw Bay was usually found along the Michigan coast south of the bay, but cases were noted where greatest effect was found at stations north of the bay or eastward into the open lake. Along the Canadian shore assemblages were qualitatively and quantitively dissimilar from assemblages in Saginaw Bay. On the basis of our results southern Lake Huron appears to be a somewhat more disturbed region than generally realized. Phytoplankton assemblage modifidation appears to result from both the influence of nutrients and other materials entering the lake directly and from the dispersal of populations from highly eutrophic Saginaw Bay into the open lake. The wide dispersal of these populations is of special interest since it may furnish a mechanism for transport of nutrients and toxic material from highly impacted Saginaw Bay into the open lake. (Author's abstract)
W81-04697

**WATER CONSTRAINTS IN POWER-PLANT SITING AND OPERATION; WISCONSIN POWER PLANT IMPACT STUDY,**
Wisconsin Univ.-Madison. Inst. for Environmental Studies.
N. Tetrick, and E. Joeres.
Available from the National Technical Information Service, Springfield, VA 22161 as PB80-226640,

Price codes: A07 in paper copy, A01 in microfiche. Environmental Protection Agency Report EPA-600/3-80-077, July, 1980. 127 p, 27 Fig, 9 Tab, 23 Ref, 7 Append.

Descriptors: *Power plants, *Environmental effects, *Water pollution effects, *Thermal pollution, Water quality, Model studies, Simulation, Dissolved oxygen, Biochemical oxygen demand, Algae, Low flow, Nutrients, Water temperature, *Wisconsin, Wisconsin River.

A conceptual study of water quality in the Wisconsin River between Wisconsin Dells and Lake Wisconsin was performed to determine the range of choices that might be available for determining the trade-off between organic waste discharges and heat assimilation from possible power plant sites. The QUAL-3 river quality model, as modified by the Wisconsin Department of Natural Resources for use on the upper Wisconsin and lower Fox Rivers, was used for preliminary simulations of the effect of potential heat discharges from three possible power plant sites on the levels of dissolved oxygen, biochemical oxygen demand, and algae growth during times of extremely low flow. Hydraulic parameters for the QUAL-3 model were estimated from simulations employing the Army Corps' HEC-2 water surface profile model. Estimates of river temperature downstream of heat discharges were obtained using a simple one-dimensional river temperature model developed by Paily and Macagno (1976). Results of simulations at various levels and locations of heat discharges are presented in the presence and absence of discharge at the Portage Wastewater Treatment Plant effluent into the Wisconsin River, and of concerted control of point and non-point sources of nutrients in and upstream of the regional study. The results suggest that the levels of dissolved oxygen in Lake Wisconsin would be most sensitive to nutrient levels in the Wisconsin River and that elevated nutrient levels resulting from heat discharges could cause greater drops in the dissolved oxygen levels in the lake.
W81-04698

**ECOLOGICAL STUDIES OF FISH NEAR A COAL-FIRED GENERATING STATION AND RELATED LABORATORY STUDIES; WISCONSIN POWER PLANT IMPACT STUDY,**
Wisconsin Univ.-Madison. Inst. for Environmental Studies.
*J. J. Magnuson, F. J. Rahel, M. J. Talbot, A. M. Forbes, and P. A. Medvick.*
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-103715, Price codes: A06 in paper copy, A01 in microfiche. Environmental Protection Agency Report EPA-600/3-80-078, July, 1980, 121 p. 20 Fig, 20 Tab, 86 Ref, 5 Append.

Descriptors: *Powerplants, *Coal, *Wetlands, *Fish, *Environmental effects, *Toxicity, *Water pollution effects, Habitats, Pike, Fish populations, Marshes, Water temperature, Thermal pollution, *Wisconsin.

Construction of a coal-fired electric generating station on wetlands adjacent to the Wisconsin River has permanently altered about one-half of the original 1,104-ha site. Change in the remaining wetlands continues as a result of waste heat and ashpit effluent produced by the station. Leakage of warm water from the 203-ha cooling lake is causing a shift in the wetlands from shallow to deep-water marsh. Coal-combustion byproducts enter the wetlands from the station's ashpit drain. Since this area was known to have a diverse fish community and to be a spawning ground for Wisconsin River game fish, the effects of this habitat loss and degradation on fish population were studied. Three years of netting documented the continued use of this area by spawning fish despite extensive habitat alterations. Construction of the power plant resulted in a loss of 18% of the shallow water sedge meadow formerly available in this section of the Wisconsin River. Loss of deep water sedge meadow was negligible. In situ and laboratory experiments showed that the ashpit effluent was not acutely toxic to eggs or larvae of northern pike, although some reduction in hatchability was attributed to the flocculent precipitate found in the ashpit drain. Analysis of population structures of northern pike showed a weak year-class for fish hatched in the first post-operational year. A bioassay utilizing temperature preference and activity proved no more sensitive than bioassay methods used by previous investigators. A population of flagfish selected for zinc tolerance was more resistant than the control population for the first two generations but not after three generations. (Moore-SRC)
W81-04704

**METHODOLOGY FOR EVALUATING THE IMPACT AND ABATEMENT OF COMBINED SEWER OVERFLOWS; A CASE STUDY OF ONONDAGA LAKE, NEW YORK,**
Stearns and Wheeler, Cazenovia, NY.
P. E. Moffa, J. C. Byron, S. D. Freedman, J. M. Karanik, and R. Ott.
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-141913, Price codes: A07 in paper copy, A01 in microfiche. Environmental Protection Agency Report EPA-600/8-80-048, November, 1980. 137 p, 37 Fig, 17 Tab, 50 Ref.

Descriptors: *Combined sewer overflows, *Urban runoff, *Onondaga Lake, *Mathematical models, *Storm runoff, Pollution load, Dissolved oxygen, Bacteria, Cost analysis, Recreation, Swimming, Water pollution control, Public health, New York.

A general methodology is presented for the evaluation of the impact and abatement of combined sewer overflows on receiving waters. It was developed from experience with Onondaga Lake, an urban lake in central New York that receives combined sewer overflows from the City of Syracuse via three tributary streams. Field measurements were made of representative combined sewer overflows and the receiving water for the purpose of developing individual mathematical models. These models were employed to project the magnitude of pollutant load from a combined sewer system for different storm conditions and the associated receiving water impact, respectively. The results of these two models can be combined to express the abatement cost to achieve different water quality standards. A maximum DO deficit of 2.8 mg/l in Onondaga Lake was predicted for a 10-year storm. Bacterial violations can occur as many as 38 times during an average rainfall year. Abatement beyond the 'cost-effective' point will be necessary to assure the lake's use for contact recreation.
W81-04719

**SPATIAL DISTRIBUTION AND TEMPERATURE SELECTION OF FISH NEAR THE THERMAL OUTFALL OF A POWER PLANT DURING FALL, WINTER AND SPRING,**
Minnesota Univ., Minneapolis.
*M. J. Ross, and D. B. Siniff.*
Available from the National Technical Information Service, Springfield, VA 22161 as PB80-148703, Price codes: A07 in paper copy, A01 in microfiche. Environmental Protection Agency Report EPA-600/3-80-009, January, 1980. 129 p, 28 Fig, 17 Tab, 62 Ref, 5 Append.

Descriptors: *Thermal pollution, *Fish behavior, *Perch, *Pike, *Bass, *Spatial distribution, Seasonal distribution, Powerplants, Thermal stress, Water temperature, Water depth, Walleye, Ice cover, Vegetation, Environmental effects.

Studies were initiated to determine the degree of concern that should be rendered yellow perch inhabiting an environment receiving a heated water discharge. A portion of the upper Mississippi River near Cohasset, Minnesota, receiving a heated discharge from a coal-fired power plant, was chosen for the study site. The movement patterns of yellow perch, northern pike, largemouth bass, and walleye were monitored by radio telemetry near the thermal discharge. Fish movements relative to depth, temperature, center of the home range, discharge point, and release location were examined. Near thermally altered areas northern pike exhibited the greatest amount of movement followed by yellow perch, walleye and largemouth bass. Except for largemouth bass, thermal experience was found to be transitory. An overall mean winter temperature selection of 5.4 C was determined for yellow perch. While only in the thermally altered area yellow perch had a slightly higher mean thermal experience, 6.3 C. Yellow perch were not found to be attracted from the surrounding areas into the heated waters of the discharge bay during the cooler months. Not until spring was a population concentrating influence observed and that was believed due to indirect influences: more cover due to greater available light in the ice free area contributing to a higher standing stock of aquatic vegetation. Temperature, when in concert with numerous other environmental variables, did not alter the distribution of yellow perch from that predicted on the basis of laboratory temperature preference studies. Furthermore, movement patterns of northern pike, walleye and largemouth bass were found to be relatively similar to those reported from thermally unaltered areas. (Moore-SRC)
W81-04723

**MATHEMATICAL MODELS OF WATER QUALITY IN LARGE LAKES, PART 1: LAKE *HURON AND SAGINAW BAY*,**
Manhattan Coll., Bronx, NY. Environmental Engineering and Science Program.
For primary bibliographic entry see Field 2H.
W81-04725

***MATHEMATICAL MODELS OF* WATER QUALITY IN LARGE LAKES, PART 2: LAKE ERIE,**
Manhattan Coll., Bronx, NY. Environmental Engineering and Science Div.
For primary bibliographic entry see Field 2H.
W81-04726

**BIOLOGICAL ASPECTS OF EUTROPHICATION,**
Illinois Univ. at Urbana-Champaign.
For primary bibliographic entry see Field 2H.
W81-04735

**CHANGES IN NESTING BEHAVIOR AND *LIPID CONTENT OF A MARINE AMPHIPOD* (AMPHITHOE VALIDA) TO THE TOXICITY OF A NO. 2 FUEL OIL,**
Texas Univ. at Austin, Port Aransas. Port Aransas Marine Lab.
W. Y. Lee, S. A. Macko, and J. A. C. Nicol.
Water, Air and Soil Pollution, Vol 15, No 2, p 185-195, 1981. 4 Fig, 1 Tab, 43 Ref.

Descriptors: *Amphipods, *Oil, *Toxicity, Bioindicators, Lipids, Nesting, Sublethal effects, Water pollution effects.

Attempts were made to investigate both the chemical and biological responses of a marine animal to the stress of a fuel oil. The nest building amphipod, Amphithoe valida, was used as the bioassay animal and the WSF (water soluble fractions) of a No. 2 fuel oil as the pollutant. Survival and nesting behavior were observed daily, and the lipid contents were checked at the end of exposure and at the end of depuration. Survival was high at all concentrations tested. However, a delayed toxicity was noted, with mortality being high in concentrations greater than 15% WSF during depuration. The number of nests decreased with increasing concentrations of WSF and length of exposure. When placed in clean seawater the recovery of the nest building ability was either small or non-existent. Lipid contents of the amphipods were close to the expected range following exposure, but dropped to about 1% following recovery compared with an expected value of 3.3%. Compared to the potential indicators of sublethal stress, the nesting behavior and lipid content of amphipods were fairly sensitive to sublethal stress. (Baker-FRC)
W81-04788

**THE EFFECTS OF A SIMULATED REFINERY EFFLUENT AND ITS COMPONENTS ON THE ESTUARINE CRUSTACEAN, MYSIDOPSIS BAHIA,**

Virginai Polytechnic Inst. and State Univ., Blacksburg. Dept. of Biology.
A. L. Buikema, Jr., B. R. Niederlehner, and J. Cairns, Jr.
Archives of Environmental Contamination and Toxicology, Vol 10, No 2, p 231-239, 1981. 6 Tab, 20 Ref.

Descriptors: *Industrial wastes, *Crustaceans, *Toxicity, Effluents, Estuarine environment, *Oil refineries, Simulation analysis, Water pollution effects, Forecasting.

The potential for ecological damage from petroleum refinery wastes has led to the development of stringent guidelines for such discharges. Laboratory toxicity tests provide the first approximation of the levels of discharge presenting the potential for harm. By screening discharges with representative or sensitive invertebrates rather than fish, substantial savings in time, space, and money may be possible in the preliminary stages of hazard evaluation. The crustacean Mysidopsis bahia was used in the evaluation of the acute and chronic effects of a simulated refinery effluent and its individual components. The 96-hour LC50 for M. bahia was 4.7% of the artificial refinery mixture. The mysid was found to be more sensitive than an estuarine fish and grass shrimp, as well as 17 freshwater organisms previously tested. Fuel oil was the most toxic component of the refinery mixture and contributed disproportionately to the toxicity of the mixture. Chronic exposure to 2.7% of the mixture formation resulted in growth inhibition by day 8 and reproductive impairment. Long-term exposure to the 96-hour LC10 had deleterious effects on growth and/or reproduction for each component tested. (Carroll-FRC)
W81-04793

**THE INFLUENCE OF ORGANIC CHEALTORS ON THE TOXICITY OF COPPER TO EMBRYOS OF THE PACIFIC OYSTER, CRASSOSTREA GIGAS,**
California Univ., Lawrence. Lawrence Livermore Lab.
J. P. Knezovich, F. L. Harrison, and J. S. Tucker.
Archives of Environmental Contamination and Toxicology, Vol 10, No 2, p 241-249, 1981. 1 Fig, 5 Tab, 6 Ref.

Descriptors: *Oysters, *Toxicity, *Copper, Chelating agents, Organic compounds, Heavy metals, Industrial wastes, Shellfish, Ecosystems.

The amounts and forms of heavy metals in fresh, estuarine, and coastal waters are increasing as a result of perturbation of ecosystems by man. The effect of increased concentrations of these metals on commercially cultured shellfish is of concern because of the desirability of maintaining a replicating shellfish resource and water quality permitting normal development. The effects of copper on the development of Crassostrea gigas embryos were determined using a 48-hour static bioassay. In filtered, sterilized seawater, the LC100 was 20 micrograms of copper per liter and the LC50 was 12 micrograms of copper per liter. Destruction of the naturally occurring dissolved organic material in the culture water by ultraviolet oxidation decreased embryo survival at 10 micrograms of copper per liter. The addition to seawater of the following five organic chelators increased embryo survival: ethylenediaminetetraacetic acid (EDTA), sodium citrate, glycine, oxalate, and humic matter. EDTA and humic matter were the most effective chelators: EDTA significantly increased survival at 100 micrograms of copper per liter and humic matter did so at 40 micrograms of copper per liter. The ability of a chelator to increase survival was related to the stability constant of the copper-chelator complex. These results indicate that the amounts and types of organic ligands in seawater are important in determining copper toxicity to oyster embryos. (Carroll-FRC)
W81-04794

**DISTRIBUTION AND ABUNDANCE OF BENTHIC INVERTEBRATES IN A SONORAN DESERT STREAM,**
Arizona State Univ., Tempe. Dept. of Zoology.
For primary bibliographic entry see Field 2E.
W81-04837

**EFFECTS OF CADMIUM ON THE COMPLETELY MIXED ACTIVATED SLUDGE PROCESS,**
California Univ., Davis.
A. S. Weber, and J. H. Sherrard.
Journal of the Water Pollution Control Federation, Vol 52, No 9, p 2378-2388, September, 1980. 7 Fig, 6 Tab, 26 Ref.

Descriptors: *Cadmium, *Nitrification, *Activated sludge process, Heavy metals, Metals, Wastewater treatment, Water pollution effects, Microorganisms, Toxicity.

The effects of Cd on chemical oxygen demand removal efficiency, degree of nitrification, and the kinetic coefficients Ymax and b were studied in the laboratory using bench scale activated sludge units and Cd concentrations 0, 5.15, and 9.98 mg per liter. The microbial growth coefficients Ymax and b were not affected by Cd concentrations up to 10 mg per liter. COD removal efficiencies were slightly less in the Cd-containing reactors than in the control at mean cell residence times from 3 to 15 days. However, nitrification was noticeably inhibited by the presence of Cd. For 5 mg per liter influent Cd, nitrification was 70% of the control, and for 10 mg per liter, 40% of control, (Cassar-FRC)
W81-04841

**GROWTH OF A COCCOID NANOPLANKTER (EUSTIGMATOPHYCEAE) FROM THE CHEASPEAKE BAY AS INFLUENCED BY LIGHT, TEMPERATURE, SALINITY AND NITROGEN SOURCE IN FACTORIAL COMBINATION,**
Maryland Univ., College Park. Dept. of Botany.
For primary bibliographic entry see Field 5B.
W81-04852

**SYSTEMS ANALYSIS FOR DESCRIPTION OF ENVIRONMENTAL POLLUTION,**
Institut National de la Recherche Scientifique, Sainte-Foy (Quebec).
D. Couillard.
Water Supply and Management, Vol 5, No 2, p 183-194, 1981. 3 Fig, 1 Tab, 20 Ref.

Descriptors: *Systems analysis, *Environmental effects, *Water pollution effects, Graphical analysis, Mathematical analysis, Kraft mills, Industrial wastes, Project planning.

A technique was developed which permits a systematic determination of the environmental effects of pollutants. First, an impact evaluation matrix is built which identifies all of the causes and effects known. A cause-effect matrix or a cause-condition-effect matrix can be used. Coherence graphs, a formal framework permitting a schematic visualization of the interrelationships between an action and its result, are useful. The flexible structure of coherence graphs facilitates the introduction of as many condition levels as required and improves the bi-dimensional cause-effect format of the matrix. A case study is presented which applies the methods discussed to the impacts of a pulp and paper factory. Coherence graphs are used to describe the kraft process, which discharges considerable amounts of toxic substances into the water. Sublethal effects on fish are illustrated. These analysis methods are applicable to virtually any subject. (Small-FRC)
W81-04853

**SUBSTRATE-ASSOCIATED MICROFAUNA,**
Texas Univ. at Dallas, Richardson.
W. T. Waller, and G. R. Lanza.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 52, No 6, p 1768-1774, June, 1980. 44 Ref.

Descriptors: *Invertebrates, *Benthic fauna, *Reviews, Toxicity, Aquatic animals, Water pollution effects, Ecology, Analytical techniques, Sampling, Nematodes, Polychaetes, Amphipoda, Protozoa, Rotifers, Organic compounds.

Studies on microfauna associated with different substrates were reviewed for 1979. Collection methods used were a lightweight portable suction dredge and several artificial substratum samplers. Analytical methods were described for quantitative estimation of protozoan populations in sand, meiobenthic nematodes in fine-grained sediments, and compressing animals between coverslip and slide. Several schemes for sampling and for analyzing data were presented. Ecologic subjects included several studies on competition between species, species distribution, habitats, respiration studies, feeding behavior, reproductive behavior, and effects of macrofauna. Toxicity tests were performed on a variety of materials. Polynuclear aromatics were increasingly toxic to polychaetes with increasing molcular weight up to the point of insolubility in water. Ni and Al chlorides suppressed reproduction at lower concentrations and were acutely toxic to 3 species of polychaetes at higher concentrations. DDT prevented decapitated planaria from regenerating lost heads at 0.4 ppm and reduced asexual fission at 0.15 ppm. Fauna inhabiting an area contaminated by wood wastes were reduced in biomass and had lost the suspension-feeding component. Polychaetes reached equilibrium conditions in water spiked with 0.65 ppm polychlorinated biphenyls after 40-60 days, and lost the PCB content in clean sediments in 2 months. A sludge disposal site had no amphipods, significantly fewer species, and reduced diversity. (Cassar-FRC)
W81-04860

**UPTAKE OF CADMIUM BY LETTUCE (LACTUCA SATIVA) AS INFLUENCED BY ITS ADDITION TO A SOIL AS INORGANIC FORMS OR IN SEWAGE SLUDGE,**
Department of Agriculture, Ottawa (Ontario). Chemistry and Biology Research Inst.
S. S. Singh.
Canadian Journal of Soil Science, Vol 61, No 1, p 19-28, February, 1981. 1 Fig, 6 Tab, 31 Ref.

Descriptors: *Cadmium, *Uptake, Plants, Crops, Sludge, Wastewater, Land disposal, Agriculture, Chemical properties, *Lettuce.

A greenhouse investigation was undertaken to measure the uptake and accumulation of cadmium by lettuce when cadmium was added as inorganic salt and in the form of inorganic precipitates with iron, aluminum, calcium, and maganese; to evaluate and compare plant uptake of cadmium when similar amounts of cadmium were added in sewage sludges; and to measure the residual effect of the above treatments on a second crop of lettuce. For two levels of added cadmium, 2.5 and 5.0 ppm, and for two successive crops grown on the same soil, the average cadmium concentration of plants grown in soil treated with inorganic forms was five times greater than that of plants from soils treated with sewage sludge containing cadmium at the same concentrations. Lower amounts of inorganic cadmium were taken up from soils treated with manganese oxide-cadmium precipitates than from cadmium precipitates with iron and aluminum hydroxides and with lime. Use of the DTPA extractions of soils to determine the amount of cadmium uptake by plants when cadmium is incorporated from heterogeneous sources is noted to give slightly less certain results. (Baker-FRC)
W81-04867

**CHANGES IN THE MINERAL COMPOSITION OF FOOD AS A RESULT OF COOKING IN 'HARD' AND 'SOFT' WATERS,**
Rijkinstituut voor Drinkwatervoorziening, Leidschendam (Netherlands).
B. S. A. Haring, and W. Van Delft.
Archives of Environmental Health, Vol 36, No 1, p 33-35, January/February, 1981. 1 Fig, 2 Tab, 14 Ref.

Descriptors: *Drinking water, *Foods, *Hardness, Mineral water, Chemical properties, Mineral composition, Public health, Calcium, Magnesium, Lead, Nutrition, Food preparation.

During the last decade, numerous epidemiologic studies have revealed an inverse relationship be-

tween water hardness and cardiovascular disease mortality. It seems unlikely that this relationship can be attributed solely to a deficiency of calcium and magnesium ingested via drinking water, because only 10 to 20 percent of the total daily intake of calcium and magnesium is derived from drinking water. A study was performed to investigate changes in the mineral composition of food when cooked in waters of different hardness. The most significant differences were found for calcium; the concentration of this element in potatoes and vegetables usually increased when cooking with hard-water types, while a decrease was noted when soft water was used for cooking. In all cases magnesium was extracted from food; extraction was slightly higher in the case of cooking with soft water. Lead concentrations in food were found to be higher after cooking with hard water and lower after cooking with soft water; however, this was probably due to the higher Pb contents of the hard water types. (Carroll-FRC)
W81-04873

**EFFECTS OF DECHLORINATION ON EARLY LIFE STAGES OF STRIPED BASS (MORONE SAXATILIS),**
Academy of Natural Sciences of Philadelphia, Benedict, MD. Benedict Estuarine Research Lab.
For primary bibliographic entry see Field 5G.
W81-04887

**PATTERNS OF INTOXICATION OF SHELLFISH IN THE GULF OF MAINE COASTAL WATERS,**
Maine Dept. of Marine Resources, West Boothbay Harbor.
J. W. Hurst, and C. M. Yentsch.
Canadian Journal of Fisheries and Aquatic Sciences, Vol 38, No 2, p 152-156, 1981. 3 Fig, 10 Ref.

Descriptors: *Shellfish, *Algal toxins, Poisons, Coastal waters, Toxins, Seasonal, Eutrophication, *Maine, Dinoflagellates, Red tide, Marine algae.

Shellfish samples were collected from coastal Maine stations in order to study the patterns of accumulation of paralytic shellfish poisoning toxins and to evaluate the use of such data for tracing algal bloom dynamics. Seasonal changes were noted in shellfish toxin levels in Mytilus edulis at three nearshore stations and one offshore station. Major toxicity was noted during the spring or late summer, when water temperatures are changing. Intraannual variability was noted at all stations. The rates of intoxication and detoxification were very rapid. No toxicity was recorded above 90 microg/100 g tissue at any point along the Maine coast from April to mid-September 1977. Examinations of water samples collected from those areas deemed 'toxin-free' did not show the presence of Gonyaulax tamarensis var. excavata in the plankton, and resting cysts were not common in the sediments. It was concluded that the patterns established in the toxin levels may be useful as tracers of bloom dynamics. (Baker-FRC)
W81-04897

**THE IMPACT OF SURFACE MINE RECLAMATION ON HEADWATER STREAMS IN SOUTHWEST VIRGINIA,**
Arizona Univ., Tucson. School of Renewable Natural Resources.
For primary bibliographic entry see Field 4A.
W81-04901

**HIGH BARIUM LEVELS IN PUBLIC DRINKING WATER AND ITS ASSOCIATION WITH ELEVATED BLOOD PRESSURE,**
Illinois Univ. at the Medical Center. School of Public Health.
G. R. Brenniman, W. H. Kojola, P. S. Levy, B. W. Carnow, and T. Namekata.
Archives of Environmental Health, Vol 36, No 1, p 28-32, January/February, 1981. 2 Tab, 21 Ref.

Descriptors: *Barium, *Drinking water, *Public health, Water quality standards, Heavy metals, Blood, Standards, Illinois, Hypertension, Human diseases.

A maximum contaminant level for barium in drinking water has been set at 1.0 milligrams per liter. Acute human and animal exposures have demonstrated that the single most characteristic action following barium ingestion is an intense stimulation of the smooth, striated, and cardiac muscles. The possible existence os significant differences in mean blood pressure levels between a high and a low barium community was examined. A total of about 2,400 Illinois residents in West Dundee, with a mean barium drinking water level of 7.3 milligrams per liter, and in McHenry, with a mean barium level of 0.1 milligrams per liter, were studied. All other drinking water constituents were nearly identical between the two communities: the only major difference was the level of barium ingested. No significant differences were found in blood pressures between the high and low barium communities. Adjustments for duration of exposure, home water softeners, and high blood pressure medication did not alter the findings. The data from this study suggest that elevated levels of barium in drinking water do not significantly elevate blood pressure levels in adult males or females. It is recommended that the drinking water standard of 1.0 milligrams per liter is re-examined for other possible health effects. (Carroll-FRC)
W81-04909

**UPTAKE AND DEPURATION OF PETROLEUM HYDROCARBONS BY CRAYFISH,**
Fish and Wildlife Service, Laurel, MD. Patuxent Wildlife Research Center.
I. B. Tarshis.
Archives of Environmental Contamination and Toxicology, Vol 10, No 1, p 79-86, 1981. 2 Fig, 38 Ref.

Descriptors: *Metabolism, *Hydrocarbons, *Crayfish, Water pollution effects, Aquatic animals, Crustaceans, Oil, Path of pollutants, Laboratory studies, Fate of pollutants, Absorption, Excretion, Radioactive tracers.

Although there has been considerable research on petroleum hydrocarbon uptake and depuration by marine invertebrates, little research has been conducted on the uptake of petroleum hydrocarbons by freshwater invertebrates during variable exposure periods and the subsequent depuration by these invertebrates in oil-free water. The uptake of labeled water-soluble fractions of No. 2 fuel oil by freshwater crayfish and their depuration in the crayfish on exposure in oil-free, non-aerated water was investigated. No differences were noted in the amount of naphthalene uptake by individual crayfish exposed for 1, 2, or 4 hours at 25C in open, non-aerated glass jars containing 14C-naphthalene-5 percent of a water-soluble fraction of No. 2 fuel oil. The cephalothorax, containing the hepatopancreas (a food absorption organ), showed greater uptake of naphthalene than the tail flesh or tail skeleton of individual crayfish exposed to the oil for 3 hours at 25C. Crayfish exposed to the oil for 1,2, or 4 hours and then placed in open, non-aerated containers of oil-free water lost most of the carbon-14 activity during the first 24 hours, with smaller losses occurring at 24 hour intervals up to and including 96 hours. Carbon-14 labeled naphthalene in a 5 percent water-soluble fraction of No. 2 fuel oil held in 12 open, non-aerated oil-free glass jars for 1, 2, 3, 4, and 5 hours at 25C showed little volatilization. (Carroll-FRC)
W81-04940

**THE EFFECT OF CALCIUM ON CADMIUM TOXICITY IN THE FRESHWATER AMPHIPOD, GAMMARUS PULEX (L.),**
Maryland Univ., Solomons. Chesapeake Biological Lab.
D. A. Wright, and J. W. Frain.
Archives of Environmental Contamination and Toxicology, Vol 10, NO 3, p 321-328, 1981. 3 Fig, 2 Tab, 24 Ref.

Descriptors: *Cadmium, *Calcium, *Amphipods, *Water pollution effects, Toxicity, Mortality, Gammarus pulex, Crustaceans, Invertebrates, Growth stages.

LC-50 values for adult intermolt Gammarus pulex exposed to cadmium in artificial stream water containing 20 mg per liter calcium were 0.12 and 0.68 mg Cd per liter for 96 and 48 hour tests, respectively. Ca had an antagonistic effect on Cd toxicity. At a Ca concentration of 200 mg per liter and Cd concentration of 0.5 mg per liter, mortality reached 40% at about 100 hours and remained constant until the end of the test at 120 hours. Decreasing amounts of Ca (2 to 80 mg per liter) in the presence of a constant 0.5 mg per liter Cd protected from Cd toxicity to a decreasing extent. Cd uptake by Gammarus pulex exposed to 0.5 mg per liter Cd for 48 hours and different Ca concentrations were as follows (mg per g on a wet basis): zero Ca, 0.0584; 20 mg per liter Ca, 0.0486; and 200 mg per liter Ca, 0.0275. Post-molt animals were 200 times as sensitive to Cd as the intermolt specimens, showing the same mortality rate at 0.1 mg per liter and 2.0 mg per liter, respectively. A possible explanation is competition between Cd and Ca for binding sites associated with physiological processes at the soft, low Ca post-molt stage. (Cassar-FRC)
W81-04941

**SHORT-TERM ACUTE BIOASSAYS TO EVALUATE AMMONIA TOXICITY AND EFFLUENT STANDARDS,**
Madison Metropolitan Sewerage District, WI.
P. J. Ruffier, W. C. Boyle, and J. Kleinschmidt.
Journal of the Water Poilution Control Federation, Vol 53, No 3, p 367-377, March, 1981. 7 Fig, 10 Tab, 39 Ref.

Descriptors: *Ammonia, *Bioassay, *Toxicity, Effluents, Water quality standards, Measurement techniques, Wastewater treatment, Fish, Water pollution effects.

In planning a new advanced secondary treatment plant for the Madison Metropolitan Sewerage District in Wisconsin, it became evident that the proposed discharge limitations for ammonia were the most critical factor in facility design. Since only limited data were availale on the actual effects of ammonia nitrogen in wastewater on fish and aquatic life in the natural environment, eight 96-hour, short-term, continuous-flow bioassays were conducted at the wastewater treatment plant to investigate the effect on fish of ammonia nitrogen in a complex, variable wastewater. The purpose of the studies was to evaluate the acceptability of the water quality criterion for non-ionized ammonia recommended by the Environmental Protection Agency (EPA). Bluegillsunfish and rainbow trout were exposed to fluctuating ammonia concentrations occurring in the secondary effluent. The LC 50 values estimated in this study were consistent with those reported in the literature for constant ammonia dosages and far exceeded the value currently recommended by EPA. The interaction of such factors as the degree of fluctuation in ammonia concentration, the mean ammonia concentration, and the acclimation abilities of the test fish appeared to be the cause of the acute toxicity of the ammonia-bearing wastewaters. (Carroll-FRC)
W81-04951

**EFFECT OF CHLORINATED COLIFORMS ON PROTOZOAN POPULATION GROWTH,**
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
S. G. Berk, and J. A. Botts.
Journal of the Water Pollution Control Federation, Vol 53, No 3, p 396-397, March, 1981. 1 Fig, 8 Ref.

Descriptors: *Population dynamics, *Chlorination, *Protozoa, Coliforms, Bacteria, Aquatic animals, Food chains, Environmental effects, Ecology.

Previous research has hypothesized that residual chlorine in wastewater effluents may inhibit the activities of predators, allowing injured coliforms to multiply until predator growth can occur to restore stability. This paper reports an investigation of the effect of ingesting chlorinated and nonchlorinated coliforms on predator population growth. Laboratory investigations involved following protozoan population growth in test tubes containing a suspension of washed ciliated protozoa and chlorinated or nonchlorinated Escherichia coli. The protozoan population growth was found

to be inhibited when the population fed on the chlorine-treated bacteria. The study results show that in areas where the chlorine concentration is not sufficient to inhibit protozoa, predation on killed coliforms may occur. Although the chlorinated bacteria provide nutritional material to the protozoa, secondary productivity is less than that resulting from nonchlorinated bacterial food sources. It is suggested that the decreased production of protozoa may have an impact on the ecology of aquatic environments subjected to wastewater effluents, since higher-order predators depend on these protozoa for their food. (Carroll-FRC)
W81-04956

**MERCURY LEVELS IN SIX SPECIES OF AUSTRALIAN COMMERCIAL FISH,**
New South Wales State Fisheries, Sidney (Australia).
R. Chvojka, and R. J. Williams.
Australian Journal of Marine and Freshwater Research, Vol 31, No 4, p 469-473, 1980. 1 Fig, 2 Tab, 3 Ref.

Descriptors: *Mercury, *Fish, Pollutants, *Australia, Commercial fishing, Heavy metals, Water pollution effects, Sublethal effects.

Since 1974, the New South Wales State Fisheries in Australia has conducted investigations of the mercury content of various commercially important species. This paper reports the results of investigations of six additional species selected to enlarge the data bank on mercury levels in commercial and recreational fishes of New South Wales. The fish chosen for this study were John dory, mirror dory, tiger flathead, rubberlip morwong, jackass morwong, and sand whiting. Data on the length, total mercury content, and methyl mercury content of each species studied are presented. The total mercury content was regressed against fish length, and the reslutant equations and correlation coefficients are presented for each of the six species. In order to provide a quick estimate of possible problems associated with mercury contamination, length-mercury content curves from the sample data were overlaid on length-frequency histograms derived from market sources. Calculation of the integrated average mercury content (milligrams of mercury per kilogram of body weight) yielded the following figures: sand whiting, 0.08; rubberlip morwong, 0.13; tiger flathead, 0.14; John dory, 0.14; mirror dory, 0.15; and jackass morwong, 0.16. Although a few of the individual sample fish exceeded the recommended mercury level, those individual fish were unusually large and the possibility of eating them regularly is very small. It was concluded that limited mercury is being consumed in the species tested. (Carroll-FRC)
W81-04965

**LIMNOLOGICAL STUDIES IN ENVIRONMENTAL SCIENCES (IN JAPANESE),**
Shinshu Univ., Ueda (Japan). Lab. of Applied Ecology.
Y. Sakurai.
Japanese Journal of Limnology, Vol 41, No 3, p 132-137, July, 1980. 5 Fig, 1 Tab, 6 Ref.

Descriptors: *Limnology, *Environmental effects, *Europhication, Lake Suwa, Japan, Water pollution effects, Water pollution control, Chemical oxygen demand, Nutrients, Phytoplankton, Algae, Nitrogen compounds, Phosphorus compounds, Organic matter.

Environmental science has reached a stage where it can relieve some of the undesirable effects of human interference. In particular, much valuable information has been acquired from studies on eutrophied Lake Suwa. From 1972 to 1976, chemical oxygen demand (COD) of the surface water of Lake Suwa showed regular seasonal fluctuations, ranging from a minimum of just over 1 mg/liter in January, 1975, to a maximum of more than 30 mg/liter in August, 1973. Suspended solids showed a similar fluctuation, within the range of 1-50 mg/liter. Chlorophyll-z contents were closely correlated with total COD. Parameters recommended for inclusion into the administrative program for Lake Suwa include total, suspended matter, and dissolved matter contents of organic carbon, COD, phytoplankton (chlorophyll-a), nitrogen (organic and inorganic), and phosphorus. Further limnological work should be done on the effects of sewage system construction andother subjects. (Cassar-FRC)
W81-04967

**PHOSPHORUS UTILIZATION AND STORAGE IN BATCH CULTURES OF THE DINOFLAGELLATE PERIDINIUM CINCTUM F. WESTII,**
Weizmann Inst. of Science, Rehovot (zisreal). Dept. of Isotopes Research.
For primary bibliographic entry see Field 2H.
W81-04975

**INADEQUACY OF ESCHERICHIA COLI AS AN INDICATOR OF WATER POLLUTION IN A TROPICAL CLIMATE: A PRELIMINARY STUDY IN BOTSWANA,**
University of the Witwatersrand, Johannesburg (South Africa). Dept. of Genetics.
For primary bibliographic entry see Field 5A.
W81-04996

## 5D. Waste Treatment Processes

**REUSE OF INDUSTRIAL WASTEWATER BY THE EXTRACTION OF ORGANIC CHEMICALS THROUGH POROPLASTIC MEMBRANES,**
Moleculon Research Corp., Cambridge, MA.
L. D. Nichols, A. S. Obermayer, M. B. Allen, and S. E. Campbell.
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-238602, Price codes: A03 in paper copy, A01 in microfiche. Office of Water Research and Technology Report OWRT/RU-80/10, September 28, 1980. 41 p, 11 Fig, 4 Tab, 2 Ref. OWRT-C-90083-R(No 9456)(1), 14-34-0001-9456.

Descriptors: *Wastewater treatment, *Industrial wastewater, *Water reuse, Membrane processes, Organic chemicals, Separation techniques, Poroplastic membranes.

Much industrial chemistry creates wastewater which cannot be reused because of contaminants which, if recoverable, would in fact have significant ecomonic value. Conventional wastewater renovation methods are not adequate to meet this growing need. The objective of this study has been to demonstrate the feasibility of modular membrane extraction systems based on POROPLASTIC materials. The technical concepts underlying membrane operations resemble those involved in liquid-liquid extraction systems, while potentially avoiding the large equipment, liquid volumes, and organic losses associated with liquid mixing and settling operations. The program included laboratory membrane studies on real and artificial wastewaters, and analysis of the results in terms of practical commercial utility. Results on both phenol and acetic acid are quite positive; a favorable economic analysis based on the experimental data for removing phenol is included in this report. The program also included extensive liaison with industry and agencies to establish the most important areas for application of membrane extraction technology. Real needs seem to be characterized by many diverse contamination problems; an important virtue of modular membrane systems .s now seen to be their ready adaptability to different applications, and the feasibility of employing them on individual process waste streams before contaminants from different sources are mixed together. Further work, to demonstrate on-site pilot operation of a prototype membrane system, is being planned.
W81-04652

**CHEMISTRY AND APPLICATION OF OZONE AND OZONE/UV LIGHT FOR WATER REUSE,**
Westgate Research Corp., Los Angeles, CA.
E. Leitis, J. D. Zeff, and M. M. Smith.
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-238578, Price codes: A08 in paper copy, A01 in microfiche. Office of Water Research and Technology Report OWRT/RU-80/14, May, 1981. 120 p, 37 Fig, 36 Tab, 7 Ref, 3 Append. OWRT-C-90110-R(No 9436)(1), 14-34-0001-9436.

Descriptors: *Ultraviolet radiation, *Ozonation, *Ozone, *Organic compounds, *Wastewater treatment, *Water reuse, Oxidation, Substrate, Halogens, Aliphatic hydrocarbons, Alkaline water, Phenols, Aromatic compounds.

The study's aim was to find ways to reduce fixed and operating costs of ultraviolet light (UV) enhancement of ozone (O3) oxidation of refractory organics in wastewater and to elucidate the chemistry involved as well as the predictability of degradation rates for different classes of refractory compounds. The study investigated the (1) role of UV wavelength and intensity on the oxidation rate of organics; (2) effect of pH and concentration of substrates on ozonation and UV ozonation rates; (2) effect of pH and concentration of substrates on ozonation and UV ozonation rates; (3) feasibility of using Oc/UV to oxidize phenanthrene, used as a model compound of polyclear aromatic hydrocarbons found in synthetic fuel wastewater. The observations derived from the experimental results included: (1) there is a concerted attack by UV light and ozone on the carbon-halogen bond, followed by a reaction of the dehalogenated carbon with ozone; (2) the rate of ozonation of organics in the presence of UV light is not increased when the pH of water is in the 8-11 range; (3) a correlation exists between the concentration of the substrate in water and the enhancement of the rate of its ozonation in the presence of UV; and (4) ozonation of phenanthrene with UV light increased the oxidation rate four times over ozone alone. (de Coquereaumont-IPA)
W81-04656

**EVALUATION OF POLLUTION CONTROL PROCESSES, UPPER THOMPSON SANITATION DISTRICT,**
M and I, Inc., Fort Collins, CO.
B. A. Hegg, K. L. Rakness, L. D. DeMers, and R. H. Cheney.
Available from the National Technical Information Service, Springfield, VA 22161 as PB80-212855, Price codes: A11 in paper copy, A01 in microfiche. Environmental Protection Agency Report EPA-600/2-80-016, June, 1980. 234 p, 30 Fig, 42 Tab, 6 Ref, 8 Append.

Descriptors: *Wastewater treatment, *Water pollution control, *Advanced wastewater treatment, *Disinfection, Ozone, Nitrification, Filtration, Activated sludge process, Ammonia.

The Upper Thompson Sanitation District (UTSD) advanced waste water treatment facility, located in Estes Park, Colorado, incorporated several unique unit processes. Among these were flow equalization, attached growth nitrification, mixed media filtration and ozone disinfection. Plant design flow was 5,680 cu m/day (1.5 mgd to 1.0 mgd). The activated sludge, nitrification and filtration processes have two parallel trains. By selectively using one half of the available units design flow conditions were achieved at one-half the plant design flow rate. Overall plant performance in terms of BOD5 and TSS removal was consistent, averaging 95% and 96%, respectively. Ammonia oxidation was not as consistent, due to loading extremes and cold weather operating conditions. Performance characteristics of two nitrification tower media types (plastic dumped and redwood slats) were different. The air-fed ozone disinfection system was operated intermittently because of required modifications. Special studies were conducted to determine performance information. When operating, good disinfection performance was achieved.
W81-04683

**COLLECTION AND ANALYSIS OF PURGEABLE ORGANICS EMITTED FROM WASTEWATER TREATMENT PLANTS,**

Research Triangle Inst., Research Triangle Park, NC.
E. D. Pellizzari, and L. Little.
Available from the National Technical Information Service, Springfield, VA 22161 as PB80-213143, Price codes: A10 in paper copy, A01 in microfiche. Environmental Protection Agency Report EPA-600/2-80-017, March, 1980. 215 p, 25 Fig, 36 Tab, 15 Ref, 4 Append.

Descriptors: *Wastewater treatment, *Aeration, *Pollutants, Gas chromatography, Mass spectrometry, Chemical analysis, Wastewater analysis, Oxygenation, Activated sludge process, Organics.

A method was developed for the analysis of volatile priority pollutants in airstreams passing through wastewaters using a Tenax GC cartridge in combination with gas chromatography/mass spectrometry/computer. The aeration systems examined during the course of this project were designed to provide agitation alone (aerated grit chamber) or to provide both oxygen and agitation (activated sludge). Recovery of the volatile priority pollutants was accomplished by thermal desorption, purging with helium into a liquid nitrogen cooled nickel capillary trap, and gas chromatography. Characterization and quantification of the priority pollutants was accomplished by mass spectrometry using mass fragmentography. The range and sensitivity varied considerably from one priority pollutant to another. The accuracy and reproducibility of this method was + or - 10% to + or - 30%. Gas chromatography/mass spectrometry analysis was extremely sensitive and specific for volatile priority pollutants in air streams from wastewaters of municipal wastewater treatment plants. The sensitivity was generally between 1-10 ng/l of air. The combination of the gas chromatographic column and the selection of specific or unique ions yielded a relatively specific assay for these priority pollutants. (Moore-SRC)
W81-04685

**PERFORMANCE EVALUATION OF THE AERATED LAGOON SYSTEM AT NORTH GULFPORT, MISSISSIPPI,**
Tulane University, New Orleans, LA. Dept. of Environmental Health Sciences.
A. J. Englande, Jr.
Available from the National Technical Information Service, Springfield, VA 22161 as PB80-187461, Price codes: A12 in paper copy, A01 in microfiche. Environmental Protection Agency Report EPA-600/2-80-006, March, 1980. 253 p, 17 Fig, 32 Tab, 2 Ref, 2 Append.

Descriptors: *Secondary wastewater treatment, *Wastewater facilities, *Monitoring, *Water quality standards, *Aerated lagoons, Evaluation, Biochemical oxygen demand, Suspended solids, Coliforms, Residual chlorine, Design criteria, Gulfport, Mississippi.

Municipal aerated wastewater treatment lagoons are extensively employed throughout the United States, but reliable long-term performance and operational data to evaluate capabilities with respect to Federal Secondary Treatment Standards are generally lacking. This report presents the data collected over a one-year monitoring period at the Orange Grove Lagoon System located in Gulfport, Mississippi. During the study period the treatment system did not exceed the federal biochemical oxygen demand average monthly requirement of 30 mg/l nor the seven consecutive day limit of 45 mg/l. The stringent permit level of 15 mg/l set by the Mississippi Air and Water Pollution Control Commission, however, was exceeded in all cases. A yearly average of 30.7 mg/l of total suspended solids was recorded. The system never exceeded federal or state pH criteria. Fecal coliform standards of 200 colonies/100 ml were met only during the months of January and February. Non-compliance was due to low residual chlorine levels resulting from poor design and operational control. Other parameters including wastewater flow, temperature, DO, algal cell counts, COD, total phosphorus, total and organic and inorganic nitrogen were also monitored, and are summarized and discussed. Well designed and operated multicelled aerated lagoons in similar climates should be capable of meeting the Federal Secondary Treatment Standards. Additional polishing may be required if there are more stringent limitations imposed for discharge into water quality limited receiving waters. (Brambley-SRC)
W81-04686

**WASTEWATER STABILIZATION LAGOON--INTERMITTENT SAND FILTER SYSTEMS,**
Utah Water Research Lab., Logan.
J. S. Russell, E. J. Middlebrooks, and J. H. Reynolds.
Available from the National Technical Information Service, Springfield, VA 22161 as PB80-201890, Price codes: A16 in paper copy, A01 in microfiche. Environmental Protection Agency Report EPA-600/2-80-032, March, 1980. 351 p, 94 Fig, 42 Tab, 36 Ref, 3 Append.

Descriptors: *Wastewater treatment, *Stabilization lagoons, *Sand filters, *Monitoring, *Water quality standards, Suspended solids, Capital costs, Operating costs, Design criteria, Maintenance, Personnel, Filtration.

The performance of three prototype lagoon-intermittent and filtration systems were evaluated for three 30 consecutive day periods during different seasons throughout a sixteen month period. Twenty-four different parameters were monitored on 24-hour composite samples. Design criteria, operation and maintenance procedures, and costs were collected and evaluated for each system. Operation and maintenance requirements were relatively small, but overall lagoon-intermittent sand filtration performance was affected by operator skill and experience. Actual manpower requirements at the three sites ranged from 0.14 to 2.0 man-years and Secondary Treatment Discharge Standards were satisfied by all three systems with the exception that 85% removal of the influent suspended solids concentration was not accomplished during two of the nine sampling periods. The intermittent sand filters were necessary for each system to satisfy the discharge standards. Annual capital costs for the three systems ranged from $0.02 to $0.05/cu m of filtrate while annual operating costs ranged from $0.01 to $0.02/cu m of filtrate. Design and cost data for 13 additional lagoon-intermittent sand filtration systems is also presented. The results clearly indicate that intermittent sand filtration is a viable low cost method for upgrading wastewater lagoon effluent. The results of the study were used to develop design criteria for an intermittent sand filter system, and a design for a typical intermittent sand filter is presented.
W81-04688

**UPGRADING PRIMARY TANKS WITH ROTATING BIOLOGICAL CONTACTORS,**
Bogert (Clinton) Associates, Fort Lee, NJ.
A. Gutierrez, I. L. Bogert, O. K. Scheible, and T. J. Mulligan.
Available from the National Technical Information Service, Springfield, VA 22161 as PB80-198583, Price codes: A10 in paper copy, A01 in microfiche. Environmental Protection Agency Report EPA-600/2-80-003, March, 1980. 215 p, 53 Fig, 28 Tab, 4 Ref, 2 Append.

Descriptors: *Primary wastewater treatment, *Secondary wastewater treatment, *Biological treatment, *Sedimentation, Seasonal variation, Soluble solids, Biochemical oxygen demand, Wastewater facilities, Oxygen, Mass transfer, Kinetics, Temperature.

A one-year experimental program was conducted at Edgewater, New Jersey, to evaluate the concept of upgrading existing primary wastewater treatment plants to secondary treatment by the installation of rotating biological contractors (RBC's) in the primary sedimentation tanks. The basic concept was to divide a primary sedimentation tank horizontally into two zones by installing an intermediate floor at mid-depth. Four RBC's were placed in the upper zone above the intermediate floor. This zone provided separate biological contact and treatment of the incoming wastes, while the lower zone functioned as a secondary sedimentation zone. Such a configuration would minimize the need for additional tankage and clarifiers, and would be especially suited to plants with limited space. The experimental program was conducted in three phases over a full year. Three loadings were studied during the initial phase to determine the optimum system load that conformed with EPA standards. This loading was then evaluated under summer and winter conditions. Optimum loadings were in the range 9-11 g/d/sq m, on a total 5-day BOD basis with influent organic concentrations on the order of 140 mg/l 5-day BOD and 125 mg/l total soluble solids. Little difference in treatment efficiency was noted between summer and winter conditions, due primarily to the interactions of oxygen availability, mass transfer, and kinetic removal rates, and the impact of temperature on each. (Brambly-SRC)
W81-04703

**EVALUATION OF FULL-SCALE TERTIARY WASTEWATER FILTERS,**
Northwestern Univ., Evanston, IL.
J. A. FitzPatrick, and C. L. Swanson.
Available from the National Technical Information Service, Springfield, VA 22161 as PB80-221021, Price codes: A10 in paper copy, A01 in microfiche. Environmental Protection Agency Report EPA-600/2-80-005, May, 1980. 210 p, 84 Fig, 30 Tab, 47 Ref, 4 Append.

Descriptors: *Wastewater treatment, *Filtration, *Clarification, *Tertiary wastewater treatment, Model studies, Mathematical models, Filter media, Suspended solids, Shock loads, Municipal wastewater.

Conventional methods for treatment of municipal wastewaters frequently produce effluents that will not meet local discharge requirements. Granular media filters are being installed to provide tertiary treatment for increased removals of suspended solids and BOD. The clarification efficiency of eight full scale tertiary granular media filters was characterized using conventional design and operating parameters, such as influent suspended solids and flow rate, and properties of secondary effluent suspensions (refiltration, particle size). Clarification efficiency is only weakly dependent on filter media depth and media grain size. Better correlations have been obtained for grab compared to composite sample data. Refiltration parameters were shown to have a very strong correlation with filter performance for plants where straining filtration was believed to be the dominant particle collection mode. Semiempirical mathematical models were developed to characterize in-depth and straining filtration. The models developed may be applied with some caution to predict filter suspended solids removal or clarification efficiency without pilot-scale tests. An important design consideration for small scale tertiary wastewater filters was found to be the ability to handle shock loads caused by secondary process upsets. This consideration generally favors those designs with slow rate of headloss development. (Moore-SRC)
W81-04706

**GUIDANCE DOCUMENT FOR THE CONTROL OF WATER POLLUTION IN THE PHOTOGRAPHIC PROCESSING INDUSTRY,**
Environmental Protection Agency, Washington, DC.
W. C. Barber, Jr., S. Schatzow, J. D. Denit, and G. E. Stigall.
Report EPA-440/1-81/082-9, April, 1981. 274 p, 40 Fig, 57 Tab, 100 Ref, 2 Append.

Descriptors: *Industrial wastes, *Photographic processing industry, *Water pollution control, *Wastewater treatment, *Heavy metals, Economics, Water conservation, Advanced waste water treatment, Silver, Chromium, Cadmium, Cyanide.

The photographic processing industry consists of facilities which process various silver halide sensitized photographic products for external customers. There are about 11,000 such facilities in the United States. The emphasis of information gathering in this study was on plants with production of more than 93 sq m product per day, which as a

group accounts for 1,100 plants and 88% of the U.S. production. The toxic pollutants in the plant wastewater are silve, cyanide, and chromium. Silver is present in all wastewater, but cyanide and chromium are only present when the facilities use bleaches containing them. Cadmium may be present in some wastewaters as it is a component of some photographic emulsions. Up to 85% of the silver and cyanide are recovered, using conventional in-process controls, primarily for the economic benefits. Some plants are using advanced in-process controls such as ion exchange, reverse osmosis, countercurrent washing, and wash water recycle, which produce conservation and environmental benefits. There may also be a cost benefit for the larger plants. No facilities are known to regenerate chromium from their wastewater, but treatment systems are available to do so. Pollutant levels in wastewater are given in kg/100 sq m of product, to encourage water saving. The plant mean data, after the basic wastewater treatment, for silver, cyanide, and chromium are 0.14, 4.8, and 0.088 kg/1000 sq m, respectively. (Brambley-SRC)
W81-04709

**ENVIRONMENTAL REGULATIONS AND TECHNOLOGY; THE ELECTROPLATING INDUSTRY.**
Environmental Protection Agency, Washington, DC. Standards, Effluents Guidelines Div.
For primary bibliographic entry see Field 6E.
W81-04712

**COLOR REMOVAL FROM KRAFT MILL EFFLUENTS BY ULTRAFILTRATION,**
Champion International Corp., Hamilton, OH.
H. A. Fremont, D. J. Striley, M. H. Kleper, and R. L. Goldsmith.
Available from the National Technical Information Service, Springfield, VA 22161 as PB80-166077, Price codes: A11 in paper copy, A01 in microfiche. Environmental Protection Agency Report EPA-600/2-80-045, February, 1980. 247 p, 56 Fig, 42 Tab, 35 Ref, 7 Append.

Descriptors: *Ultrafiltration, *Color removal, *Pulp wastes, *Kraft mills, Industrial wastes, Wastewater treatment, White water, Fouling, Pulp and paper industry, Membrane processes, Economic aspects.

Conventional and generally available techniques are adequate in most cases for kraft pulp mill wastewater treatment except color removal. Color removal by ultrafiltration (UF) has been successfully demonstrated during this study. A 3-stage, nominal 37.9 cu m/day UF pilot plant was operated on caustic extraction filtrate for several months. Spirally wound UF modules showed severe flux loss within a few hours exposure to the waste stream. Membrane surface analysis identified the main stream foulants as kaolinite clay, starch and titanium dioxide from white water recycle from the paper mill. Tubular modules exhibited high, stable process flux and recoverable water flux characteristics. Membrane surface fouling was not observed with tubular modules. These modules operate under more turbulent flow than spiral-wound modules, reducing slime layer formation. Color removal by the non-cellulosic ultrafiltration membranes ranged from 97% to 99% when calculated on a concentrate basis. Conceptual designs and economic analyses were developed for treatment systems with capacities of 3,790 cu m/day and 7,980 cu m/day. (Moore-SRC)
W81-04724

**OXIDATIVE PURIFICATION OF WATER,**
Etablissements Kuhlmann, Paris (France). Produits Chimiques. (Assignee).
M-C. Daude-Lagrave.
U.S. Patent No 4,220,529, 6 p, 5 Ref; Official Gazette of the United States Patent Office, Vol 998, No 1, p 223, September 2, 1980.

Descriptors: *Patents, *Water treatment, *Wastewater treatment, *Water purification, *Oxidation, Water pollution treatment, Chemical reactions, Toxicity, Cyanides, Singlet oxygen.

A process makes it possible, regardless of the initial concentrations of toxic products contained in industrial effluents, such as cyanides, sulfocyanides, cyanohydrins, phenols, nitrites, sulfides, aldehydes, hexavalent chromium, to obtain effluents of practically zero residual toxic matter content under particularly advantageous conditions, as well as to reduce the chemical oxygen demand of raw water to a considerable extent. Briefly stated, the invention comprises oxidative purification of a water source by the use of singlet oxygen added to the water or formed in situ in the water source. In a singlet state, all electrons of a molecule compensate their spins two by two, while in the triplet state two electrons are present with their spins parallel. In the majority of cases, the ground state of molecules is a singlet state, with oxygen being a notable exception because its normal state is a triplet, and the two possible singlet states are obtained only by certain chemical reactions or by photochemical treatment of triplet oxygen. (Sinha-OEIS)
W81-04738

**FLOTATION PURIFICATION APPARATUS,**
Oy Nokia A. B., Helsinki (Finland). (Assignee).
P. T. Sammatti.
U.S. Patent No 4,220,532, 4 p, 2 Fig, 2 Ref; Official Gazette of the United States Patent Office, Vol 998, No 1, p 224, September 2, 1980.

Descriptors: *Patents, *Wastewater treatment, *Water pollution treatment, *Separation techniques, Equipment, Industrial wastes, Pulp and paper industry, Flotation, Flocculation, Bubbles.

For the purification of solids-containing liquids, such as fines-containing waters from paper machines, it is previously well-known to use the so called flotation method according to which the solids are by means of flocculating chemicals and finely divided air bubbles agglomerated to form flocks rising to the liquid surface, from which they can be removed from the flotation tank. It is an object of this invention to provide a purification apparatus which eliminates certain disadvantages of prior work, and which is characterized in that the outlets of the distributing channel are directed toward the corner between the bottom of the flotation tank and the partition wall. Due to the fact that the partial flows discharged by the distributing channel are directed into the corner, the cinetic energy of the partial flows is consumed when they collide with the corner and their direction is changed into the opposite as the liquid starts to flow through the retarding zone into the separation zone. In this way it is possible to supply the liquid to be purified in considerably larger amounts per time unit without a risk that the numerous partial flows cause only disadvantageous unitary turbulence and circulation in the tank. (Sinha-OEIS)
W81-04740

**METHOD OF EXTRACTING SLUDGE FROM SEWAGE,**
S. R. Kennedy.
U.S. Patent No 4,221,656, 8 p, 3 Fig, 17 Ref; Official Gazette of the United States Patent Office, Vol 998, No 2, p 612, Sepember 9, 1980.

Descriptors: *Patents, *Wastewater treatment, *Separation techniques, Sludge, Equipment, Circulation, Aeration.

The sewage treatment apparatus comprises a primary liquid circulation chamber where sewage is circulated around a curved circulation guide barrier that shields an outlet port. The sewage circulates due to the introduction of pressurized air into the chamber liquid. The air is directed along a predetermined path, thereby influencing liquid circulation. The circulation guide barrier extends between opposite walls of the chamber to prevent the liquid from crossing over the barrier to the outlet port. The outlet port is located substantially central of the circulating liquid and the sludge that is present in the liquid tends to move radially away from the outlet part. Liquid entering the outlet port is thus rendered substantially free of sludge. The radially moving sludge tends to sink to the bottom of the primary circulation chamber and is drawn outwardly by suction apparatus comprising a perforated suction pipe placed at the bottom of the chamber. (Sinha-OEIS)
W81-04746

**BIOLOGICAL FERMENTATION SUBSTRATES,**
Omnium d'Assainissement, Paris (France); (Assignee). and Argles et Mineraux, Montguyon (France). (Assignee).
Y. Lebesgue.
U.S. Patent No 4,221,657, 3 p, 3 ref; Official Gazette of the United States Patent Office, Vol 998, No 2, p 612, September 9, 1980.

Descriptors: *Patents, *Wastewater treatment, *Biological treatment, *Filters, Microorganisms, Nutrients, Trace elements, Substraces.

According to a now-classic method of wastewater treatment, microorganisms are used to digest pollutants either in the form of sludges activated in fermentation basins or tanks or in the form of bacterial beds where the zoogloeas, composed of microorganisms or the like, are retained on a fixed substrate serving as a filtration bed for the water to be purifice. The problem arises of developing and having available a bacterial bed where all the species of microorganisms normally used always enjoy a maximum growth rate and where the biomass is fully retained and uniformly distributed on the filtration bed. This invention concerns substrates for biological filters which are made of fired clays, in the form of medium-sized granulates (2 to 25 mm) containing small quantities of trace elements serving as nutrients for the microorganisms adhering to the substrates. (Sinha-OEIS)
W81-04747

**PROCESS FOR REDUCING DICHLOROBUTENE CONTAMINATION IN AQUEOUS PLANT WASTES,**
Du Pont de Nemours (E.I.) and Co., Wilmington, DE.
A. T. Harris, T. J. Kelly, and T. W. Redwine.
U.S. Patent No 4,221,659, 5 p, 1 Fig, 4 Tab, 3 Ref; Official Gazette of the United States Patent Office, Vol 998, No 2, p 613, September 9, 1980.

Descriptors: *Patents, *Wastewater treatment, *Water pollution treatment, *Industrial wastes, *Separation techniques, Chemical reactions, Sodium chloride, Chlorinated organic compounds, Hydrocarbons, Neoprene rubber.

Chlorinated organic compounds from the aqueous waste streams from a process for manufacturing and isomerizing dichlorobutenes and dehydrochlorinating 3,4-dichlorobutene-1 to chloroprene, which is the principal monomer in the manufacture of neoprene rubber, are removed by means of a process, wherein the aqueous waste from the dichlorobutene-isomerization step and brine formed in the dehydrochlorination step are combined to produce an aqueous solution containing about 1-5% sodium chloride and the solution, while maintained at a pH of less than about 6, is extracted with a small amount of a liquid hydrocarbon. The liquid hydrocarbon extract is then incinerated, while the extracted aqueous solution is discharged into a natural body of water. In this way, the level of 1,4-dichlorobutene-2, which is toxic to fish, in the natural body of water can be maintained at a safe level. (Sinha-OEIS)
W81-04748

**SYSTEM FOR SEPARATING AND REMOVING OIL BASED MATTER FROM LIQUIDS SUCH AS WATER,**
G. Ravagnan.
U.S. Patent No 4,221,669, 7 p, 11 Fig, 10 Ref; Official Gazette of the United States Patent Office, Vol 998, No 2, p 616-617, September 9, 1980.

Descriptors: *Patents, *Wastewater treatment, *Oil pollution, *Water pollution treatment, *Separation techniques, Adsorption, Equipment, Floating.

The invention relates to an improved system for separating and removing oil based matter from liquids such as water, the system being particularly useful in the continuous treatment of aqueous liquids including thick oil residue, as are to be found in the drain tanks for the waste of industrial plants. The objects of the invention are achieved by an improved system comprising a number of vertical rotating discs, partly immersed in the liquid, means operative to separate from the discs those materials which adhere and to convey such materials to a first container, means adapted to discharge, periodically and/or upon weighing, the materials from the first container, and means for preferentially conveying the materials present on the liquid surface toward the discs. (Sinha-OEIS)
W81-04750

**TOWARDS IMPROVING THE SPECIFIC RATING OF CUP SCREENS IN SEWAGE FLOWS,**
Imperial Coll. of Science and Technology, London (England). Public Health Engineering Lab.
A. Stamper, and N. J. D. Graham.
Water Pollution Control, Vol 80, No 1, p 121-130, 1981. 9 Fig, 1 Tab, 8 Ref.

Descriptors: *Screens, *Filters, Specific yield, Sieves, *Wastewater treatment, Performance evaluation, Pilot plants.

Attempts to achieve higher specific ratings in terms of the relationship between the volume of water screened and the area of the screening surface have been stifled by the problems and uncertainties associated with the phenomenon of mesh blinding, whereby fine strands of screening solids weave in and out of the screen openings and lead to total screen blockage. Understanding the influence of opening velocity on the component factors of the total screen head loss expression should facilitate design compromises between increasing the specific rating and avoidance of mesh blinding and excessive head losses. In order to evaluate the implications of adopting higher specific ratings, as part of a general study of the performance of rotary-cup screens in crude sewage, a pilot plant unit was installed at a wastewater treatment plant with facilities to vary the influent sewage-flow rate, the speed of screen rotation, and downstream depth of screen submergence. The operating performance of the pilot plant was studied using a range of screen-opening velocities, and this performance was compared with that of a full-scale cup-screen plant of identical screen design at varying screen-opening velocities. Mesh blinding did not occur either during the pilot plant study or in long-term operation of the full-scale plant. Variations in screen performance were found to be dependent on filtrability constant and clean-water screen head loss. Since both of these factors are intrinsically dependent on the nature of the screen, the design choice of opening size, shape, pattern, and related factors is of major significance. Increasing the rotation speed of the screen was found to minimize the clean water head loss. Since the screen submergence depth is the principal flow control, attention must be given to the downstream hydraulic conditions when attempting to increase the specific rating. Therefore, the principal material savings in the design of the screen are in the screen width rather than in the diameter. (Carroll-FRC)
W81-04784

**THE TREATMENT OF COAL CARBONIZATION WASTE WATERS IN ADMIXTURE WITH SEWAGE,**
Yorkshire Water Authority, Sheffields (England). Southern Div.
I. R. Hall, and R. E. Paine.
Water Pollution Control, Vol 80, No 1, p 54-69, 1981. 11 Tab, 16 Ref.

Descriptors: *Industrial wastewater, *Municipal wastewater, *Wastewater treatment, Activated sludge, Biological treatment, Effluents, Water pollution, Ammonia, Secondary wastewater treatment, Coal, Phenols, Chemical wastes, Yorkshire, Great Britain.

The Southern Division of the Yorkshire Water Authority is responsible for the control of water pollution in an area which includes a high population density as well as a significant number of industries. The low dilution available for sewage effluent and the direct discharge of industrial effluents, particularly those from the coal carbonization industry, contribute to a major pollution load in the river system. Two experimental programs were instituted to investigate possible methods of treating the coal carbonization effluents. Full-scale trials carried out at the Wath sewage treatment facility used a typical high-temperature carbonization effluent which had received prior biological treatment, while laboratory-scale trials were carried out using an atypical effluent containing only 25 percent low-temperature carbonization liquor combined with effluent from a refinery and associated chemical processing plant. The full-scale trials demonstrated that the typical effluent could be successfully treated in a 10 percent volume to volume admixture with sewage at a treatment plant using the alternating double filtration process, resulting in a significant overall reduction in the ammonia released to the river. The atypical effluent was successfully treated in admixture with sewage in a laboratory-scale activated sludge plant using as much as 20 percent volume to volume industrial effluent in admixture with sewage. Nitrification in the laboratory-scale unit could be increased by buffering and could be maintained at prevailing winter temperatures. The permanganate value and color of the industrial effluent used in the laboratory-scale tests could be reduced by treatment with iron. (Carroll-FRC)
W81-04786

**ANAEROBIC SLUDGE DIGESTION--NEED IT BE EXPENSIVE. MAKING MORE OF EXISTING RESOURCES,**
Severn-Trent Water Authority (England). Lower Trent Div.
C. E. Brade, and G. P. Noone.
Water Pollution Control, Vol 80, No 1, p 70-94, 1981. 8 Fig, 5 Tab, 52 Ref.

Descriptors: *Anaerobic digestion, *Sludge digestion, *Economic aspects, Biological treatment, Sludge, *Wastewater treatment, Costs, Capital costs, Wastewater facilities, Heating, Mixing, Solids.

As a result of recent reports on the disposal of sewage sludge to land, water authorities in Great Britain are preparing for further restrictions on the disposal of untreated sludges to land. The Severn-Trent Water Authority has conducted some preliminary work in a full-scale plant to aim at improving and extending treatment processes while minimizing the resultant capital and revenue requirements. A survey of 15 facilities with 39 digestion tanks within the Severn-Trent Water Authority area was conducted to study the range of variations in current practice and the way in which the physical and mechanical design of the process plants related to their performance as reactors converting organic materials into gaseous reaction products. A full-scale study was undertaken to investigate the problems which could be expected when sludge throughput was increased until failure occurred. An existing plant was then selected for evaluation of a number of methods of providing heated primary digestion within existing volumetric resources through the addition of process equipment which was effective and highly reliable and which required a minimum use of fuel. The findings of the survey and the results of the two plant studies are summarized in a method of approach to provide increased sludge process capacity through maximization of existing resources. This approach included upgrading of the primary reactor primarily by improving mixing and heating, increasing the solids loading, and heat conservation measures. This paper was presented to a meeting of the West Midlands Branch held at the University of Aston, Great Britain, on March 28, 1979. A discussion of the paper, a reply paper presented at a later meeting, and discussion of the reply paper are also included. (Carroll-FRC)
W81-04787

**DISTRIBUTION OF VIRUSES ASSOCIATED WITH PARTICLES IN WASTEWATER,**
Florida State Univ., Tallahassee. Epidemiology Research Center.
For primary bibliographic entry see Field 5B.
W81-04795

**OPERATION AND DESIGN OF BIOLOGICAL LEACHATE TREATMENT PLANTS,**
Technische Univ., Brunswick (Germany, F.R.).
R. Stegmann, and H. J. Ehrig.
Water Science and Technology, Vol 13, No 2, p Tor 919-947, 1981. 20 Fig, 2 Tab, 8 Ref.

Descriptors: *Leachates, *Wastewater facilities, *Design criteria, Landfills, Sanitary landfills, Lagoons, Aerated lagoons, Wastewater lagoons, Pilot plants.

Aerobic lagoons were operated with leachates from different sanitary landfills as pilot plants in a laboratory experiment. Design considerations for aerobic biological treatment plants were studied. Such plants should be based on BOD5-concentrations and leachate production rates as evaluated from pilot studies. Aerated lagoons as well as activated sludge plants can be used for complete treatment of organic leachate compounds as characterized by BOD5-concentrations. BOD5 concentrations should be less than 25 mg/l. This degree of BOD5 can be achieved if sufficient phosphorus and nitrogen are available in the leachate and if adequate organic loadings with respective detention times are chosen for the design of the plant. The organic load which is chosen for the design is dependent upon the BOD5-COD ratio of the leachate. Treatment plants should be planned in such a way as to allow for flexible operation if possible. Aerated lagoons must be equipped with a settling tank to collect the produced sludge in a concentrated way. Another possible design involves the placing of a sequential operation of an activated sludge plant followed by continuous fermentation processes by the time when the BOD5/COD-ratio decreased to below 0.5. (Baker-FRC)
W81-04806

**TREATMENT EFFECTS AND POLLUTION DANGERS OF SECONDARY EFFLUENT PERCOLATION TO GROUNDWATER,**
Sewage Reclamation Department, Tel Avid (Israel).
E. Idelovitch, and M. Michail.
Water Science and Technology, Vol 13, No 2, p Tor 949-966, 1981. 12 Fig, 2 Tab, 4 Ref.

Descriptors: *Groundwater pollution, *Percolation, *Oxidation ponds, Ponds, Lagoons, Oxidation lagoons, Effluent, Waste water treatment, Groundwater pollution, Wells.

The groundwater aquifer east and south-east of the oxidation ponds associated with the Dan Region Reclamation Project in Israel have been under study due to possible contamination by the effluent from the wastewater treatment plant. The treatment ponds are located in an area of sandy soils, which has a large clay lens underlying them at about 10 m depth. The nearest public wells are at distances of 250 to 450 m east of these ponds. These wells were affected by the seepage which occurred from the oxidation ponds before a recharge with tertiary effluent was planned in 1977. Hydrogeochemical monitoring was conducted using a network of observation wells placed between the ponds and the public wells. Several important pollutants were removed by passage through the soil aquifer, including phosphorus, particulate organic matter, coliform bacteria, cadmium, and chromium. Good removal was also obtained for soluble organics. Complete nitrification and good denitrification were obtained during a period of several years, but then an increase in nitrogen concentration occurred, indicating that anaerobic conditions were prevailing in the aquifer which impeded the completion of the nitrification process. The main dangers relating to groundwater pollution by seepage of effluents from oxidation ponds appear to be connected with soluble organics and unoxidized nitrogen forms. (Baker-FRC)
W81-04807

**NITROGEN REMOVAL IN A SUBSURFACE DISPOSAL SYSTEM,**
Suffolk County Dept. of Health Services, Hauppauge, NY.
A. Andreoli, R. Reynolds, N. Bartilucci, and R. Forgione.
Water Science and Technology, Vol 13, No 2, p Tor 967-976, 1981. 1 Fig, 4 Tab, 14 Ref.

Descriptors: *Denitrification, *Wastewater, Groundwater pollution, Nitrates, Septic tanks, Methanol, Long Island, Effluents, *Nitrogen removal.

This study encompasses the design, construction, and operation of a full-scale system consisting of a conventional septic tank-leaching field waste water disposal system combined with a subsurface system using natural soil treatment mechanisms to accomplish nitrogen removal from disposal system leachate. From the study it was concluded that the septic tank reduced total nitrogen concentration of the raw wastewater about 20%. Approximately six months were required to achieve steady-state nitrification within the soil. Of the total nitrogen applied to the soil, about 36% was removed within 0.6 m of travel through the soil. Coliform removal was achieved to an excellent degree within 0.6 m of wastewater travel through the soil. Within one month of the commencement of methanol addition, denitrification was established. Almost complete denitrification was achieved within the first meter of travel through the pan with methanol feed. Where the leachate by-passed the methanol feed zone dentrification did not occur. The study demonstrated that nitrification of septic tank effluent occurs within 0.6 to 1.2 m of vertical travel in a typical Long Island soil. (Baker-FRC)
W81-04808

**THE RESPONSE OF METHANE FERMENTATION TO CYANIDE AND CHLOROFORM,**
Drexel Univ., Philadelphia, PA.
J. Yang, R. E. Speece, G. F. Parkin, J. Gossett, and W. Kocher.
Water Science and Technology, Vol 13, No 2, p Tor 977-989, 1981. 13 Fig, 19 Ref.

Descriptors: *Methane, *Industrial wastewater, Fermentation, *Cyanide, *Chloroform, Toxicity, Anaerobic conditions, Anaerobic digestion, *Wastewater treatment.

The ability of cyanide and chloroform to inhibit the formation of methane was investigated for its possible ramifications in the use of methane fermentation in the treatment of industrial wastewater and in the treatment of domestic sludges. Methane fermentation was found to have significant acclimation potential to chloroform and cyanide. Cyanide exhibited a toxicity that was readily reversible even at high concentrations after long exposure times. Chloroform exhibited some irreversible toxicity with only partial recovery of methane production after the chloroform was removed from the system. Methane fermentation was demonstrated to be capable of metabolizing acetate at stable, high rates of 3.3 kg/cubic meter per day in the presence of what would normally he considered to be extremely toxic concentrations of cyanide and chloroform. (Baker-FRC)
W81-04809

**LEAST-COST OPTIMIZATION FOR AREAWIDE (208 WASTEWATER MANAGEMENT USING MIXED INTEGER PROGRAMMING,**
Weston (Roy F.) Roslyn, NY.
K. J. Phillips, S. R. Kellogg, E. J. Beltrami, and T. O. Carroll.
Water Science and Technology, Vol 13, No 2, p Tor 991-1010, 1981. 5 Fig, 5 Tab, 3 Ref.

Descriptors: *Wastewater management, *Mathematical models, *Mixed integer programming, Cost analysis, Regional planning, Nassau County, New York.

A study of areawide wastewater management plans for Nassau County in Long Island was undertaken to comply with the federal guidelines. A mixed integer model was used to screen wastewater management alternatives. In this manner a least-cost wastewater management plan specifying location, expansion, and upgrading for 25 wastewater treatment plants in the region was accomplished. These plants were either of the trickling filter or activated sludge type. It was concluded that mixed integer programming is a useful and flexible tool, enabling the engineer to investigate a multitude of alternatives and come up with the optimal plan for wastewater management within a region. The programming model did not consume large amounts of computer time in its solution, mainly because of the preliminary engineering feasibility work that was performed at the initiation of the study itself. (Baker-FRC)
W81-04810

**EFFECTS OF CADMIUM ON THE COMPLETELY MIXED ACTIVATED SLUDGE PROCESS,**
California Univ., Davis.
For primary bibliographic entry see Field 5C.
W81-04841

**ANAEROBIC ROTATING BIOLOGICAL CONTACTOR FOR CARBONACEOUS WASTEWATERS,**
International Paper Co., Tuxedo Park, NY.
S. J. Tait, and A. A. Friedman.
Journal of the Water Pollution Control Federation, Vol 52, No 8, p 2257-2269, August, 1980. 17 Fig, 3 Tab, 5 Ref.

Descriptors: *Organic wastes, *Anaerobic digestion, *Rotating biological contactor, Wastewater treatment, Industrial wastes, Digestion, Methane, Carbon, Model studies, Organic carbon removal.

A four-stage pilot plant scale anaerobic rotating biological contactor was developed for treatment of high strength carbonaceous wastewaters. The apparatus, operated at 35C under organic loadings up to 3,400 mg per liter and various hydraulic loadings, removed between 52 and 98% of total organic carbon depending on initial substrate concentrations and hydraulic detention times. Product gas (50% methane) averaged about 1.92 cu meter per kg total organic carbon removed. A model was developed for relating the removal of soluble organic substances to the strength and feed flow rate. This system may be useful as an organic industrial waste stream treatment or pretreatment. It conserves energy by producing combustible gas and by requiring little input energy for pumping in the horizontal flow arrangement. (Cassar-FRC)
W81-04842

**KINETIC MODEL FOR CHROMATE REDUCTION IN COOLING TOWER BLOWDOWN,**
Air Products and Chemicals, Inc., Allentown, PA.
For primary bibliographic entry see Field 5B.
W81-04843

**SLUDGE HANDLING AND DISPOSAL REMAIN AS THE PERSISTENT TREATMENT PROBLEMS,**
For primary bibliographic entry see Field 5E.
W81-04846

**HOW THE PETROLEUM REFINING INDUSTRY IS FIGHTING POLLUTION,**
B. Fricay.
Water and Pollution Control, Vol 118, No 1, p 18, 20-22, January, 1980. 1 Fig, 3 Tab.

Descriptors: *Oil industry, *Industrial wastes, Oil wastes, Wastewater treatment facilities, Wastewater treatment, Water quality, Clarification, Primary wastewater treatment, Secondary wastewater treatment, Water pollution control.

Petroleum refiners cooperate with the federal and provincial governments in Canada through the Petroleum Association for the Conservation of the Canadian Environment in efforts to control pollution. The governments have a heavy responsibility to make sure that expenditures by the refiners for pollution abatement equipment are tied to a demonstrated need for pollution control, but the cost must be recovered in the price of the product. Several treatment technologies have been developed to purify water contaminated in the refining process. These include primary separation such as with an API separator, intermediate treatment such as air flotation, secondary treatment such as biological treatment, sour water stripping for ammonia and sulfide removal, segregation and treatment of storm water, if necessary, and final effluent clarification if needed. (Baker-FRC)
W81-04848

**INVESTIGATIONS INTO SLUDGE DEWATERING USING POLYELECTROLYTE CONDITIONERS AT BYBROOK SEWAGE-TREATMENT WORKS,**
Southern Water Authority (England). East Kent Div.
For primary bibliographic entry see Field 6B.
W81-04850

**EFFECT OF SLUDGE TYPE ON POLIOVIRUS ASSOCIATION WITH AND RECOVERY FROM SLUDGE SOLIDS,**
Florida Univ., Gainesville.
O. C. Pancorbo, P. R. Scheuerman, S. R. Farrah, and G. Bitton.
Canadian Journal of Microbiology, Vol 27, No 3, p 279-287, March, 1981. 5 Tab, 16 Ref.

Descriptors: *Sludge solids, *Viruses, *Wastewater treatment, Activated sludge, Digested sludge, Aerobic digestion, Anaerobic digestion, Mixed liquor solids, Process efficiency.

Although there is clearly a need to monitor viruses during sludge treatment and ultimate disposal, methods for the recovery of viruses from wastewater sludges have only recently become available. Practical methods for the recovery of viruses from sludge samples involve releasing both surface-adsorbed and solids-embedded viruses, followed by concentration of the eluted viruses prior to viral assay. The effect of the sludge type on the degree of association between viruses and sludge solids and on the recovery of sludge solids-associated viruses by the glycine method was investigated using seeded poliovirus type 1 and three sludge types. The mean percent of solids-associated poliviruses for activated sludge mixed liquors, anaerobically digested sludges, and aerobically digested sludges was 57.2, 70.4, and 94.7, respectively. Sludge solids associated viruses were eluted using 0.05 M glycine buffer, pH 10.5 to 11.0, and then concentrated by organic flocculation. The effectiveness of the glycine method in the recovery of solids-associated viruses was also found to be affected by sludge type, with significantly lower mean poliovirus recovery from aerobically digested sludges (14.5 percent) than from mixed liquors or anaerobically digested sludges (72.3 and 60.2 percent, respectively). The eluant used in the method was not as effective in dissociating the virus from aerobic sludge solids as it was for the other two sludge types. All other virus adsorption-elution steps of the method were equally effective in poliovirus recovery for all three sludge types. It is suggested that future methods developed for the recovery of viruses from sludges be evaluated for the various types of sludge likely to be tested. (Carroll-FRC)
W81-04866

**BIOLOGICAL NITROEN CONTROL IN WASTEWATERS,**
New South Wales Univ., Kensington (Australia). Dept. of Civil Engineering.
P. J. Bliss, and D. Barnes.
Effluent and Water Treatment Journal, Vol 21, No 2, p 65-68, 70-74, February, 1981. 3 Fig, 1 Tab, 17 Ref.

Descriptors: *Denitrification, *Nitrification, *Wastewater treatment, Nitrogen, Biological treatment, Biological wastewater treatment, *Australia, Drinking water, Effluents, Oxygen demand.

Various problems associated with the discharge of nitrogen to Australian waters are reviewed. These

problems center around health effects occurring via environmental effects. The overall result may be the restriction of the water for certain uses. Nitrogen can be added to a water body through various denitrification processes in the soil and water. These include microbial transformations such as fixation, assimilation, ammonification, nitrification, and denitrification. The major problems in Australia arising from the nitrogen discharge include eutrophication, involving assimilation of inorganic nitrogen and other nutrients; nitrification, with its associated oxygen demand; ammonia toxicity; and problems associated with maintaining drinking water quality. Nitrification can be achieved in any aerobic biological process at low organic loadings and where suitable environmental conditions are provided. For a typical raw sewage The Clean Waters Act restrictions imply that a high degree of nitrogen control is required in wastewater effluents discharging to inland streams having low dilution ratios. Control of nitrogen form by nitrification or nitrogen amount by nitrification/denitrification using biological processes is likely to be increasingly needed at large inland treatment plants. Nitrification critically depends on maintaining a mean cell residence time in the biological process which is well in excess of the reciprocal of the growth rate of nitrifying organisms. This requires considerably larger aeration tanks than for carbonaceous oxidation alone. Caution must be exercised in applying published kinetic data derived from laboratory and pilot scale studies to plant scale tests. (Baker-FRC)
W81-04876

**CATCH 22.**
Effluent and Water Treatment Journal, Vol 21, No 2, p 59-61, 63, February, 1981.

Descriptors: *Wastewater treatment, *History, *Great Britain, Sewage, Potable water, Domestic water, Drinking water, Wastewater dispoal, Wastewater treatment facilities, *Water treatment.

Problems of Water purity were noted in England by 1854, and the first anti-pollution legislation was passed by Parliament in 1880. Prior to World War II, water treatment rarely extended far beyond water softening. However, after the war, governments not only in Great Britain but in other industrialized nations as well moved to nationalize large chunks of industries and centralize public effluent and water treatment undertakings. A split occurred, which saw the separation of companies which made specific pieces of equipment for use in water treatment plant schemes from companies which became pure contractors without manufacturing capabilities. This pattern was general throughout the industralized world. At the end of the 1960's the government of Great Britain turned its attention to the centralization of public water supply and disposal. This had significant and far-reaching effects on the economies of the involved companies and industries. While many of the basic discoveries in the field of potable water and sewage treatment were made in England, the advancement seemed to stop with the multi-stage distillation process. Little progress has originated in England over the past few decades. (Baker-FRC)
W81-04881

**SCREEN LIQUID/SOLID SEPARATOR.**
Effluent and Water Treatment Journal, Vol 21, No 2, p 95, February, 1981.

Descriptors: *Separation techniques, *Screens, Effluents, Industrial effluents, Food-processing wastes, Sewage effluents, *Wastewater treatment.

The Vickery Bauer Hydrasieve screen is a simple device for separating liquids and solids by means of the coanda effect. The liquid forms a hydraulic attachment to the wedge bar and passes through the slots, leaving a high proportion of solids on the screen surface. The screen plate is constructed with three distinct angles from the vertical plane to encourage separation and slow the natural downward velocity of material being processed so that only separated solids are left on the final screen section, at which point final drainage occurs. The screen plate is manufactured of stainless steel and is a one-piece assembly of specially designed horizontal wedge wire bars with three angular changes of slope. Apart from periodic hosing down, screen plates do not normally require further attention. Typical applications include domestic sewage, stormwater, canning waste, packing waste, pig slurry, shellfish process effluent, meat processing waste, citrus fruit processing waste, vegetable processing waste, potato chip manufacturing effluent, instant tea manufacturing effluent, dairy effluent, tannery effluent, textile plant effluent, paper mill effluent, pulp and paper mill fiber thickening effluent, cheese fluid separation effluent, chemical processing waste, and spent grain recovery waste. (Baker-FRC)
W81-04883

**ANAEROBIC DEGRADATION OF HALOGENATED 1- AND 2-CARBON ORGANIC COMPOUNDS,**
Stanford Univ., CA. Dept. of Civil Engineering.
E. J. Bouwer, B. E. Rittmann, and P. L. McCarty.
Environmental Science and Technology, Vol 15, No 5, p 596-599, May, 1981. 1 Fig, 6 Tab, 18 Ref.

Descriptors: *Organic compounds, *Halogenated compounds, *Aerobic digestion, Trihalomethanes, Groundwater, Bacteria, Methane bacteria, Wastewater treatment, Biodegradation, Fate of pollutants.

Trihalomethanes, trichloroethylene, and tetrachloroethylene at concentrations of 10-200 micrograms per liter were incubated aerobically in the presence of primary sewage bacteria and anerobically in the presence of mixed methanogenic bacteria. None of the compounds were degraded under aerobic conditions. Under anaerobic conditions and upon seeding with methanogenic bacteria, respectively, chloroform concentration (16 weeks incubation) declines from 157 to 34 and 16 to 0.2 micrograms per liter; bromodichloromethane (2 weeks incubation) 161 to $<0.1$ and 16 to $<0.1$; dibromochloromethane (2 weeks incubation) 205 to $<0.1$ and 19 to $<0.1$; trichloroethylene (16 weeks incubation) 187 to 69 and 18 to 9: tetrachloroethylene (16 weeks) 176 to 56 and 17 to 7. The rapid degradation of the brominated trihalomethanes indicated a chemical mechanism operating in addition to the biological mechanism. Comparing the seeded 2-carbon chlorinated hydrocarbons with sterile controls showed that these were little changed over the incubation period. (Cassar-FRC)
W81-04888

**PUBLIC POLICY FOR THE USE OF RECLAIMED WATER,**
California Univ., Berkeley.
W. H. Bruvold, B. H. Olson, and M. Rigby.
Environmental Management, Vol 5, No 2, p 95-107, 1981. 6 Tab, 25 Ref.(California Water Resources Center, Project UCAL-WRC-W-563).

Descriptors: *Reclaimed water, *Public policy, *Wastewater renovation, Water reuse, Public health, Effluents, Wastewater treatment, Economic aspects, Public opinion, Environmental effects.

Important general reasons for municipalities to adopt innovative uses of reclaimed water include the economic benefits derived from deferred construction projects and related environmental benefits, the growing scarcity of unallocated surface water supply sources, reduction of the rate of groundwater depletion, and the need to protect aquatic environments from pollution and degradation. The following five levels of wastewater treatment are described: primary, secondary, tertiary, advanced, and advanced plus complete treatment. Major uses for reclaimed water include groundwater recharge, industrial use, irrigation, recreational lakes, and direct municipal reuse. Subcategories of reuse falling under each of these major reuse categories are identified and discussed. A review of significant literature relating to the health and environmental effects, treatment and distribution costs, and public opinion concerns associated with each of the five major categories of reuse and their related subcategories is then presented. The degree of wastewater treatment required for each reuse subcategory is identified. Finally, a cumulative numerical analysis of the drawbacks associated with each specific type of reuse is developed based on numerical scores for health effects, environmental effects, treatment costs, distribution costs, and public opinion concerns. Uses of reclaimed water for industrial purposes and for irrigation of fodder and fiber crops are found to be the most beneficial by means of this analysis, while use for aquifer recharge and direct municipal reuse are found to be the least beneficial. (Carroll-FRC)
W81-04898

**MARKETABLE PERMITS FOR THE CONTROL OF PHOSPHORUS EFFLUENT INTO LAKE MICHIGAN,**
Wisconsin Univ.-Madison. Dept. of Economics.
M. David, W. Eheart, E. Joeres, and E. David.
Water Resources Research, Vol 16, No 2, p 263-270, April, 1980. 1 Fig, 1 Tab, 15 Ref.

Descriptors: *Waste disposal, *Management planning, Planning, *Lake Michigan, *Phosphorus, Permits, Legal aspects, Discharge frequency, Effluent charges, Pricing.

This paper examines the problems and practicalities of establishing a system of waste load allowances which is both more equitable and more efficient than direct regulation. Marketable permits, called transferable discharge permits (TDPs), are used to achieve desired levels of pollution abatement. A TDP is not an effluent charge. Unlike the effluent charge, it does not purport to solve problems of how much waste should be assimilated in air or water resources. The TDP assumes that some maximum loading has been selected and that the problem at hand is to find an efficient means for allocating that load among dischargers, both existing and potential. For the system to encourage efficiency, dischargers who can abate pollution relatively cheaply should do most of the required cleanup. TDPs provide a mechanism for the exchange of pollution discharge units such that each discharger pays an equitable share of the costs of abatement, but only those dischargers who can abate pollution relatively cheaply are required to perform the physical treatment. This system is applied to phosphorus abatement in the Wisconsin portion of Lake Michigan Basin. The level of demand and supply for TDPs among 53 waste treatment plants is simulated, and the necessary steps to create a market are outlined. Enforcement, price changes, and future adjustments in the permissible effluent loading are shown to be compatible with the marketing process proposed. (Baker-FRC)
W81-04910

**TESTING POINTS THE WAY TO PROPER ORGANICS' TREATMENT,**
Ahmadu Bello Univ., Zaria (Nigeria). Dept. of Civil Engineering.
K. O. Iwugo.
Water and Sewage Works, Vol 127, No 4, p 42, 43, 70, 72, April, 1980. 4 Fig, 2 Tab, 18 Ref.

Descriptors: *Tertiary wastewater treatment, *Biodegradation, Wastewater treatment, Advanced wastewater treatment, Complete wastewater treatment, Organic compounds, Aeration, Municipal wastes, Industrial wastes.

There is some indication through recent reports that tertiary treatment of water has not been sufficient to render it relatively free of organic contamination. Characteristics of the pure organic substrates, the synthetic sewage, the municipal settled sewages and the experimental conditions for batch oxidation studies were calculated. Experiments indicated that the biodegradation of the pure substrates was characterized by an initial lag of up to 6 hr. The fatty acids were the least biodegradable, and the nitrogenous samples were the most biodegradable. The biodegradable patterns of the synthetic sewage indicated initial lag periods much shorter than those for pure substrates, probably reflecting lower initial values of the F/M (food/microorganism) ratios used. In the municipal sewage samples, the soluble organics were no

longer degradable after about 50 hr of aeration. Studies of continuous flow aeration on composite samples from a sedimentation tank indicated an overall maximum efficiency of 75% for the removal of TOC and about 60% for the removal of SOC. It is suggested that a suitable tertiary treatment process of municipal sewage effluents should aim to facilitate the further biodegradation of the residual soluble organics in the biological effluents. (Baker-FRC)
W81-04929

**TREATMENT OF COAL COKING AND COAL GASIFICATION WASTEWATERS,**
Carnegie-Mellon Univ., Pittsburgh, PA. Dept. of Civil Engineering.
R. G. Luthy.
Journal of the Water Pollution Control Federation, Vol 53, No 3, p 325-339, March, 1981. 5 Fig, 9 Tab, 41 Ref.

Descriptors: *Wastewater treatment, *Coal gasification, *Industrial wastewater, Coal, Biological wastewater treatment, Effluents, Wastewater composition, Wastewater dilution, Cyanide, Nitrifiation.

Although coal coking wastewaters have been treated by biological oxidation for several years, few studies have investigated optimal treatment design and operation criteria. This paper reports the results of biological oxidation studies performed with coke plant wastewaters and with effluents from coal gasification process pilot plants. Coal coking and coal gasification wastewaters have similar primary pollutants, but these pollutants are present in different proportions for the two wastewaters, Biological treatment of these wastewaters results in good removals of biological and chemical oxygen demands, phenolics, ammonia-nitrogen, and cyanogen-nitrogen. The relatively low microbial yields from biological treatment of these effluents affect the design and operation of the biological processes involved. The dilution requirements for wastewaters from coal conversion processes and the effect of different pretreatments of the wastewaters on subsequent biological treatment are discussed. Biological oxidation growth constants are developed for treatment of coal gasification and coking plant effluents, and the removal efficiencies for primary effluent contaminants are determined. Single stage nitrification has been found to be feasible on a variety of types of pretreated coal refinery wastewaters. (Carroll-FRC)
W81-04948

**DESIGN TO OPTIMIZE MULTI-STAGE UNIT PROCESSES FOR PEAK FLOWS,**
Burgess and Niple, Ltd., Columbis, OH.
R. F. Noland, and W. A. Mather.
Journal of the Water Pollution Control Federation, Vol 53, No 3, p 340-343, March, 1981. 8 Fig.

Descriptors: *Wastewater facilities, *Wastewater treatment, Flow separation, Municipal wastewater, Flow control, Sewer systems, Cost analysis, Multiphase flow.

The efficiencies of wastewater treatment units are generally hydraulically limited, with efficiencies decreasing rapidly when those limitations are exceeded. This paper presents the theory behind a design concept which is aimed at restricting the loadings to individual treatment units in order to permit them to operate at optimal efficiencies during periods of excessive flows. In systems using multiple unit processes to provide a high degree of treatment, restricting loads to unit processes and distributing loads to specific units increases the total treatment capacity under peak flow conditions. This design alternative is suitable for facilities providing a high degree of treatment for normal flows; for situations where a partially combined sewer system exists and treatment is indicated in lieu of sewer separation; and where bypasses must be eliminated, even though influent sewer capacity is greater than the treatment plant hydraulic capacity. In treatment plants with multiple stages of treatment, this design concept offers the possibility of providing treatment for up to six times the average design flows. The Painesville Water Pollution Control Plant in Ohio, which was planned in 1972, incorporated modifications of the flow pattern of the treatment process which could provide for treatment of up to five times the average daily design flow. The additional costs incurred to optimize the unit processes were small, amounting in the Painesville case to less than 1.0 percent of the total construction costs for the plant. (Carroll-FRC)
W81-04949

**SOLUBILIZATION OF PARTICULATE ORGANIC CARBON DURING THE ACID PHASE OF ANAEROBIC DIGESTION,**
Michigan State Univ., East Lansing. Dept. of Civil and Sanitary Engineering.
J. A. Eastman, and J. F. Ferguson.
Journal of the Water Pollution Control Federation, Vol 53, No 3, p 352-366, March, 1981. 13 Fig, 12 Tab, 31 Ref.

Descriptors: *Anaerobic digestion, *Organic carbon, *Solubility, Carbon, Wastewater treatment, Acids, Particulate matter, Methane, Biodegration, Volatile acids, Organic acids.

Many wastewater treatment facilities use anaerobic digestion processes for the stabilization of organic matter entering the plant. Increases in the cost of energy have led to renewed interest in anaerobic digestion for energy recovery by production of methane from waste materials. Although there is considerable literature on factors limiting methane production during the methanogenic phase, little research has been conducted on the acid phase, which comprises the processes by which waste particulates are solubilized and fermented to volatile acids. The acid phase consists of hydrolysis of degradable solids to smaller soluble molecules, followed by acid-forming bacteria using these soluble intermediates as substrates for energy and growth, resulting in the formation of fermentation products and cellular materials. This study investigated the effects of detention time, pH, and substrate concentration on the rate and extent of soluble organic carbon production and the origin and composition of the soluble organic carbon. The soluble organic carbon produced during the acid phase consists primarily of volatile acids. Both the production of soluble organic carbon and the distribution of volatile acids are significantly affected by pH. The rate-limiting step in the conversion of waste solids to fermentationproducts in the acid phase of anaerobic digestion was found to be the hydrolysis of particulates to soluble substrates. The results of the investigations were used to formulate a model of the acid phase of anaerobic digestion.(Carroll-FRC)
W81-04950

**TAHOE-TRUCKEE WATER RECLAMATION PLANT, CALIFORNIA.**
Journal of the Water Pollution Control Federation, Vol 53, No 3, p 398-400, March, 1981. 3 Tab.

Descriptors: *Reclaimed water, *Regional planning, *Wastewater renovation, Wastewater treatment, Lake Tahoe, Truckee, *California, Wastewater facilities, Economic aspects, Water quality standards.

The Tahoe-Truckee Sanitation Agency was formed in May, 1972, to implement a California State law which required exportation of all wastewater from the Lake Tahoe Basin. The Agency was charged with planning, designing, and constructing a regional system for transporting all wastewater from areas on the California shore of Lake Tahoe to a regional facility. The treatment facility, which receives only domestic and commercial wastewaters, provides primary treatment, pure oxygen activated sludge, lime treatment with two-stage recarbonation, dual media filtration, carbon adsorption, and ion exchange for ammonia removal and recovery. While effluent quality was relatively good from the start of operations in February, 1978, the quality gradually improved during the initial months of operation. Fairly stable operation was achieved between July and December, 1978, with consistent production of effluent of excellent quality. All of the very stringent discharge requirements were met except those for total dissolved solids and chloride concentration. Monitoring of the Truckee River, into which the effluent is discharged, has demonstrated that the plant is achieving its primary goals of returning reclaimed water to the basin while maintaining exceptional water quality. Construction costs for the plant were high due to the location. Operation and maintenance costs were about $450 per 1000 cubic meters during the first year of operation. Methods of reducing operating costs and/or improving plant performance are being investigated. (Carroll-FRC)
W81-04954

**START-UP OF A PHYSICAL-CHEMICAL TREATMENT PLANT,**
Stearns and Wheeler, Cazenovia, NY.
W. O. Lynch, and L. R. Potter.
Journal of the Water Pollution Control Federation, Vol 53, No 3, p 318-324, March, 1981. 3 Fig, 4 Tab.

Descriptors: *Physicochemical treatment, *Wastewater treatment, *Wastewater facilities, Activated carbon, Sedimentation, Chemical coagulation, Chlorination, Economic aspects, Industrial wastewater, Municipal wastewater, *Cortland, New York.

The city of Cortland, New York, decided in 1975 to construct a $15,250,000, 10 million gallons per day wastewater treatment plant which would provide secondary treatment of a 75 percent domestic and 25 percent industrial wastewater using physical-chemical treatment processes. The physical-chemical treatment processes comprised a combination of chemical coagulation, sedimentation, activated carbon adsorption-filtration, and breakpoint chlorination. The physical-chemical process was selected to meet the stringent effluent limitations of 1,300 kilograms of total oxygen demand and 200 kilograms of ammonia per day. Other advantages of the physical-chemical process included significant projected capital costs savings over a two-stage biological nitrification process, insensitivity to the toxic wastes received from the metallurgical industries in Cortland, no secondary sludge production, potential income from regeneration of activated carbon for others, operational flexibility, stability of the plant effluent under varying load conditions, the reduced likelihood of a complete failure of the secondary treatment process, and the relatively small land requirements. In order to meet effluent discharge requirements during the plant expansion, new units began to be phased in two years after the start of construction, and the start-up period was continued for 18 months as new units were placed into service. The primary treatment facility was upgraded and new facilities were built without interrupting primary treatment. Problems encountered during the start-up period are described. Waste treatment and effluent quality benefits resulting from the upgrading of the primary treatment system and addition of the secondary treatment processes are discussed. (Carroll-FRC)
W81-04955

**SUCCESSFUL STORAGE LAGOON ODOR CONTROL,**
Tennessee Eastman Co., Kingsport.
R. A. Poduska, and B. D. Anderson.
Journal of the Water Pollution Control Federation, Vol 53, No 3, p 299-310, March, 1981. 11 Fig, 3 Tab, 25 Ref.

Descriptors: *Odor control, *Sludge lagoons, *Industrial wastewater, Lagoons, Odors, Digested sludge, Sodium compounds, Sodium nitrate.

During the first two years of operation of the Tennessee Eastman Company(s industrial activated sudge wastewater treatment system, which treated wastewater from the manufacture of chemicals, fibers, an plastics products, lagoon storage of aerobically digested sludge was required prior to compltion of the final sludge dewatering and disposal facilities. During warm weather, a serious odor emission problem resulted from the anaerobic conditions in the storage lagoons. An intensive

laboratory study was undertaken to determine the best practical method of eliminating the odors. A review of the literature on the origin and the chemical and biological aspects of odors and on odor control is presented. Laboratory and field investigations showed that, while there were several effective odor control methods available, the method must easily implemented at the lowest costs, and with the highest poential for long-term success, was the addition of a locally obtained waste sodium nitrate liquor to the sludge storage lagoons. The oxidation-reduction potential was found to be the most satisfactory measure of the odor potential in the lagoons, followed by nitrate concentration and acetic acid concentration. The nitrate wastes serve as an electron acceptor for the facultative heterotrophic bacteria, permitting the equivalent of aerobic metabolism. In addition, nitrogen gas release provides an internal means of mixing and the nitrate reduction increases the pH and moves the hydrogen sulfide equilibria toward the non-odorous ionized sulfide species. After the initial rapid utilization demand for nitrate is complte, the maintenance requirement is small. (Carroll-FRC)
W81-04958

**BIOLOGICAL TREATMENT OF WOOL SCOURING WASTEWATER,**
North Carolina State Univ. at Raleigh. Dept. of Civil Engineering.
A. C. Chao, and W-F. Yang.
Journal of the Water Pollution Control Federation, Vol 53, No 3, p 311-317, March, 1981. 10 Fig, 5 Tab, 14 Ref.

Descriptors: *Industrial wastewater, *Wool scouring, *Biological wastewater treatment, Wastewater treatment, Activated sludge process, Wool grease, Suspended solids, Biological oxygen demand, Chemical oxygen demand, Sludge disposal.

Wool scouring wastewater contains significant quantities of suspended solids, organic matter, and grease, which often cause malfunction of the biological system used to treat the wastewater. The presence of wool grease in the wastewater tends to coat biological flocs and to reduce the oxygen transfer rates, interfering with the operation of the biological process. This paper discusses the approach taken by one wool scouring plant faced with excessively high suspended solids, organic matters and grease in the effluent from its activated sludge wastewater treatment system. The original activated sludge system consisted of a grit chamber, an oxidation ditch aeration basin, a clarifier, and sludge drying beds. Due to overloading, the grit chamber failed to remove grit, resulting in extremely high mixed liquor suspended solids in the aeration basin. Grease accumulation in the aeration basin resulted in high concentrations of soluble organic matter in the treated effluent and sludge with poor settling characteristics. In-plant separation of several component wastewater streams containing high concentrations of pollutants from the total discharge was instituted as pretreatment to reduce grease, suspended solids, and organic matter in the wastewater. The wastewater treatment system was expanded to include an aerobic digestion system and a land disposal subsurface sludge injection system. The separated process waste stream is mixed with the sludge stream from the biological treatment system and treated in the aerobic digester prior to final disposal on the land. While effluents from the original system exceeded imposed limitations, stabilization of the biological treatment system has resulted in improved effluent quality which meets the limitations with respect to biological and chemical oxygen demand, suspended solids, and grease. Groundwater samples collected before institution of the land disposal system and 6 months after the injection program was started indicated that the groundwater quality had not deteriorated over the short-term period. (Carroll-FRC)
W81-04960

**TREATMENT OF ACID MINE DRAINAGE,**
Envirex Inc., Waukesha, WI.
W. M. Throop.
Industrial Wastes, Vol 27, No 2, p 28-30, March/April, 1981. 2 Tab, 2 Ref.

Descriptors: *Acid mine drainage, *Coal mine wastes, *Mine drainage, Lime, *Wastewater treatment, Neutralization, Pennsylvania.

A process for neutralizing acid mine drainage waters in a large western Pennsylvania coal mine operation is described. Lime slurry (hydrated lime for lower acidity and quicklime for higher acidity) at a concentration of 5% is added to maintain a pH of 8.0 to 9.5. Aeration oxidizes ferrous iron to ferric iron, using 1 mg per liter oxygen for each 14 mg per liter ferrous iron. After the 15-30 min mixing and aeration, solids are coagulated with paddle wheels or turbine flocculators. The subsequent clarification process using an anionic polyelectrolyte (0.5 to 2.0 mg per liter) collects the lime sludge and conveys it to a detention basin. Sludge is usually dumped into an abandoned mine. (Cassar-FRC)
W81-04961

**SLUDGE DECOMPOSITION AND STABILIZATION,**
State Univ. of New York Coll. of Environmental Science and Forestry, Syracuse. School of Biology, Chemistry and Ecology.
R. Hartenstein.
Science, Vol 212, No 4496, p 743-749, May 15, 1981. 2 Fig, 5 Tab, 64 Ref.

Descriptors: *Sludge, *Decomposition, Decomposing organic matter, Land disposal, Sludge disposal, Microorganisms, Carbon cycle, Chemical composition.

This article attempts to present a working definition of sludge stabilization, to describe several factors relating to management whereby the rate of sludge decomposition and stabilization can be enhanced, to discuss the highly probable consequences of sludge stabilization in light of the basic information, and to suggest procedures for evaluating the sludge stabilization process. Sludges are defined as labile putrescible materials which must undergo a heterotrophic decomposition process and be subject to humification before becoming stabilized substances. When anaerobic sludges are placed on soil and exposed to air, many obligate anaerobic bacteria are killed and become subject to decay, as they are deficient in certain enzymes which protect living organisms against the toxic action of oxygen and oxygen derivatives. When aerobic sludges are placed on the land, obligate aerobic microbes die and decay when ambient conditions become anaerobic, although surface-dwelling aerobes and facultative aerobes and anaerobes may survive. In time the dead cells of either type of sludge are subject to lysis and decomposition, giving rise to putrescence. If sludge is spread thinly on the land, the potential for putreescence diminishes, increasingly to as the carbon/nitrogen and carbon/sulfur ratios increase. The various processes ocurring lead to increases in mineralization and humification. (Baker-FRC)
W81-04981

## 5E. Ultimate Disposal Of Wastes

**THE LAND AND HAZARDOUS WASTE MANAGEMENT,**
Battelle Memorial Inst., Columbus, OH. Columbus Labs.
For primary bibliographic entry see Field 5B.
W81-04772

**THE FATE OF BACTERIAL PATHOGENS IN SEWAGE TREATMENT PROCESSES,**
Thames Water Authority, London (England). Vales Div.
V. H. Lewin, P. W. Jones, and D. L. Redhead.
Water Pollution Control, Vol 80, No 1, p 42-53, 1981. 1 Fig, 8 Tab, 27 Ref.

Descriptors: *Pathogenic bacteria, *Land disposal, *Sewage bacteria, Sludge utilization, Coliforms, Salmonella, Mycobacterium, Wastewater treatment, Primary sludge, Bacteria, Agriculture, Public health.

One of the potential hazards associated with the properly controlled disposal of sewage sludge to agricultural land is the possible transfer of harmful microorganisms to humans or other mammals. The occurrence of potentially pathogenic bacteria in sewage and the effect of various treatment processes on their numbers sites were examined for the presence of salmonellae, and selected samples were examined for the presence of Bacillus anthracis, Brucella abortus, Escherichia coli, pathogenic mycobacteria, and/or pathogenic leptospires. The presence of Salmonella organisms was found to be widespread in both sewage and sewage sludges. The concentrations of salmonellae in settled sewage and untreated sludge were low. Secondary treatment of settled sewage significantly reduces the numbers of salmonellae present. While processing of raw sludge reduces the numbers of salmonellae present, the efficiency is dependent on the method of treatment. Treatment with lime or long-term storage appear to be the most effective measures. Pathogenic strains of leptospires, mycobacteria, and coliforms were present in sewage and sewage sludge, but at extremely low concentrations. Although the risk of disease transfer associated with the disposal of sewage sludges to agricultural land cannot be entirely discounted, the evidence indicates that the risk is small and is no greater than that associated with the agricultural utilization of farm slurries. (Carroll-FRC)
W81-04785

**FACTORS AFFECTING SALMONELLAE REPOPULATION IN COMPOSTED SLUDGES,**
Los Angeles County Sanitation Districts, Whttier. San Jose Creek Water Quality Lab.
C. F. Russ, and W. A. Yanko.
Applied and Environmental Microbiology, Vol 41, No 3, p 597-602, March, 1981. 2 Fig, 3 Tab, 10 Ref.

Descriptors: *Salmonella, *Bacteria, *Sludge disposal, Soil amendments, Composting, Sewage sludge, Hazards, Public health, Water pollution sources, Microorganisms, Sewage bacteria, Pathogenic bacteria.

Although bagged composted sewage sludge contains a nondetectable salmonellae population, regrowth was demonstrated under the optimal conditions of temperature 20 to 40C, moisture content 20%, volatile solids content in excess of 18 g per 100 g total solids, and C/N ratio greater than 15:1. Aerobic conditions promoted reduction of volatile solids and C/N ratio and die-off of salmonellae. Anaerobic conditions supported bacterial growth until nutrients became limiting. In conditions typical of well-composted sludge, salmonellae peaks occurred at 5 days, followed by die-off. Poorly composted sludges could support bacterial growth much longer. To minimize the potential health hazards to users of composted sludge or the threat to water quality, material should be stockpiled after composting, until the proper levels of volatile solids and C/N ratios are reached. (Cassar-FRC)
W81-04799

**PROVING THE BENEFITS OF LAND DISPOSAL OF SLUDGE,**
Monroe County Div. of Pure Waters, Rochester, NY.
For primary bibliographic entry see Field 3C.
W81-04818

**NITRATE LEACHING AND IRRIGATED CORN PRODUCTION WITH ORGANIC AND INORGANIC FERTILIZERS ON SANDY SOIL,**
Illinois Univ. at Urbana-Champaign. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 5B.
W81-04834

**VOLATILE AMMONIA LOSSES FROM SURFACE-APPLIED SLUDGE,**
Oregon State Univ., Corvallis.
C. J. English, Jr., J. R. Miner, and J. K. Koelliker.
Journal of the Water Pollution Control Federation, Vol 52, No 9, p 2340-2350, September, 1980. 7 Fig, 5 Tab, 21 Ref.

Descriptors: *Soil amendments, *Ammonia, *Sludge disposal, Volatility, Nitrogen compounds, Fertilizers, Physical properties.

Ammonia losses from sludge applied as a soil amendment were investigated. Equilibrium constants determined by laboratory measurements and by theory agreed. These constants were used to calculate the equilibrium partial pressure of ammonia gas above the sludge. Corrections were required for activity effects of ionic strength but not for variations in sludge organic content. Sludge pH increased slightly upon land application and exposure to air, a result of carbon dioxide loss. A model was developed to predict ammonia volatilization by convective mass transfer. A resulting table relates wind speed and air temperature to initial loss rate of ammonia for wind speeds of 2.5 to 35 km per hour and air temperatures of 10 to 35C. For example, at wind speeds of 2.5, 10, and 35 km per hour and an air temperature of 10C, initial loss rates were (in kg N per sq meter per hour times 10,000) 0.58, 2.4, and 8.1, respectively. At wind speeds of 2.5, 10, and 35 km per hour and an air temperature of 35C, initial loss rates were (in kg N per sq meter per hour times 10,000) 9.8, 39, and 140, respectively. (Cassar-FRC)
W81-04845

**SLUDGE HANDLING AND DISPOSAL REMAIN AS THE PERSISTENT TREATMENT PROBLEMS,**
P. Parry.
Water and Pollution Control, Vol 118, No 4, p 12-13, 27, April, 1980. 1 Fig, 3 Tab.

Descriptors: *Sludge, *Land disposal, *Incineration, Sludge cakes, Dewatering, Sludge drying, Sludge thickening, Waste disposal, Waste treatment facilities, Energy.

In many communities utilization of sludge on agricultural lands is the lowest cost sludge disposal method. It recycles a valuable source and respects the need to conserve energy. To be successful, however, this type of program must involve careful implementation and management. When environmental and economic circumstances dictate that incineration of the sludge cake is the best method of content in the sludge feed to the incinerator and the opportunity to recover part of the energy consumed in the incineration or dewatering process. When the sludge fed to the incinerator has a moisture content above 75% by weight and a volatile content below 65% by weight, auxiliary fuel will be required to evaporate and superheat the moisture in the sludge cake. When the sludge feed has a moisture of about 60% by weight, sufficient energy is released in combustion to evaporate and superheat the moisture. Energy can be recovered most efficiently from the exhaust gases in the form of steam. (Baker-FRC)
W81-04846

**UPTAKE OF CADMIUM BY LETTUCE (LACTUCA SATIVA) AS INFLUENCED BY ITS ADDITION TO A SOIL AS INORGANIC FORMS OR IN SEWAGE SLUDGE,**
Department of Agriculture, Ottawa (Ontario). Chemistry and Biology Research Inst.
For primary bibliographic entry see Field 5C.
W81-04867

**PHOSPHATE ADSORPTION BY SOIL AMENDED WITH CHEMICALLY TREATED SEWAGE SLUDGES,**
Guelph Univ. (Ontario). Dept. of Land Resource Science.
C. C. Lee, Y. K. Soon, and T. E. Bates.
Canadian Journal of Soil Science, Vol 61, No 1, p 165-168, February, 1981. 1 Fig, 2 Tab, 5 Ref.

Descriptors: *Land disposal, *Sludge, *Phosphates, Adsorption, Soil treatment, Loam, Soil conamination, Soil amendments, Metals, Soil absorption capacity, Calcium, Iron, Aluminum.

Soil was taken in July of 1979 from a field experiment with corn. The sampling site was situated on a Conestoga loam and was tile drained. Different plots received aluminum, calcium, and iron treated sludges at rates of up to 1600 kg N/ha from sludge each year since 1973. The same type and rate of sludge was reapplied to the same plot after each spring plowing. Sludge was worked in with a disc after drying. Soil samples for this study were from plots receiving 200 kg N/ha from $NH_4NO_3$ plus 40 kg P/ha from superphosphate (20% P) fertilizer each year, and from plots receiving 800 kg N/ha/yr from sludge. The soil initially had a pH of 7.3 and a cation exchange capacity of 23 meq/100 g. Phosphate adsorption was timed in the various soil samples. Adsorption was increased by sludge application in the order: calcium-sludge greater than aluminum-sludge equal to iron-sludge greater than untreated soil. Phosphate adsorption was associated with the increase in $CaCO_3$ and hydrous iron and aluminum oxide contents resulting from sludge applications. (Baker-FRC)
W81-04868

**INCUBATION OF PULVERIZED HOUSEHOLD REFUSE WITH SOIL AND SEWAGE SLUDGE, POULTRY MANURE OR $(NH_4)_2SO_4$,**
Guelph Univ. (Ontario). Dept. of Land Resources Science.
L. A. Loewen-Rudgers, L. D. King, and L. R. Webber.
Canadian Journal of Soil Science, Vol 61, No 1, p 109-121, February, 1981. 5 Fig, 4 Tab, 10 Ref.

Descriptors: *Sludge, *Land disposal, Nitrogen, Nitrates, Nitrogen cycle, Wastewater, Manure, Farm wastes, Municipal wastewater, Domestic wastes.

Waste-soil mixtures were incubated in the dark in an environmental growth chamber for 28, 56, 112, 168, and 224 days. Mixtures were kept each day for 12 hr at 20 degrees C alternating with 12 hr at 15 degrees C, 65% relative humidity, in 2-L wide-mouth glass jars closed with lids each having a small opening 0.25 cm in diameter. The soil used was Guelph loam. The percent decrease in dry weight calculated on the basis of added waste materials usually did not change extensively after 168 days. The rate of decomposition was probably more rapid than in the field study, where it was estimated that 80% of the paper in the refuse had decomposed after 1 yr. The more rapid decomposition in the incubation study may have resulted from the better mixing of the refuse with soil and the more favorable environmental conditions. Readily decomposable organic carbon decreased most rapidly during the first 56 days of incubation. Nitrate-N levels decreased during the first 28 days for all treatments that included refuse and, with little exception, remained low until 168 days, increasing only during the final 56 days. Application of sewage sludge or poultry manure alone caused substantial increases in soil nitrate levels. Total N decreased in nearly all treatments from day 28 to day 224. Soil pH was not changed by incubation duration. Application of refuse alone resulted in a pH value higher than control, but this trend was reversed with the application of N. It was concluded that before municipal refuse and high-N waste are simultaneously applied to land, the inorganic N-supplying power of the soil should be determined so that waste levels can be adjusted to avoid large accumulations of nitrate. (Baker-FRC)
W81-04869

**THE NEW HAZARDOUS WASTE MANAGEMENT SYSTEM: REGULATION OF WASTES OR WASTED REGULATION,**
For primary bibliographic entry see Field 6E.
W81-04899

**BRINGING ABOUT AN END TO OCEAN DUMPING,**
D. V. Feliciano.
Journal of the Water Pollution Control Federation, Vol 53, No 3, p 276-286, March, 1981. 6 Fig, 5 Tab.

Descriptors: *Sludge disposal, *Ocean dumping, *Political aspects, Sludge, Wastewater, Waste disposal, Philadelphia, Pennsylvania, California, Los Angeles, Waste management, Economic aspects.

The Marine Protection, Research, and Sanctuaries Act of 1972 established December 31, 1981, as the deadline to cease ocean dumping of wastewater sludge. This paper examines actions taken by Philadelphia, Pennsylvania, and by the Los Angeles/Orange County Metropolitan Area in California to find alternatives to ocean dumping. Philadelphia ceased ocean dumping of sludge in November, 1980, following the development of several land utilization alternatives. The city upgraded its treatment plants and sludge dewatering facilities. The dewatered sludge is given away to large and small users for land application and used to reclaim strip mines and for landfill reclamation. Sludge management in the Los Angeles/Orange County metropolitan area is the responsibility of three separate agencies. The City of Los Angeles has selected thermal processing of dehydrated, dewatered sludge, which includes provisions for the production of steam and electricity for use in the processing of wastewaters and sludges. The costs of this system are estimated at about $3.55 per person per year. The Los Angeles County Sanitation Districts will use a combination of thermal processing and composting and landfill disposal to replace ocean dumping of sludge. This system will provide for resource recovery through the production of electricity and steam for use in wastewater and sludge processing and through production of compost material. The estimated cost per person of this system is about $4.34 per year. The Orange County, California, Sanitation Districts will use a land-based, non-thermal processing system, with the intention of installing a thermal processing system at a later time. These examples show that environmentally acceptable and beneficial alternatives to ocean dumping of wastewater sludges are available and can be economical. (Carroll-FRC)
W81-04959

## 5F. Water Treatment and Quality Alteration

**BENEFITS OF MAINTAINING A CHLORINE RESIDUAL IN WATER SUPPLY SYSTEMS,**
Johns Hopkins Univ., Baltimore, MD. Div. of Environmental Health Engineering.
M. C. Snead, V. P. Olivieri, C. W. Kruse, and K. Kawata.
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-110892, Price codes: A09 in paper copy, A01 in microfiche. Environmental Protection Agency Report EPA-600/2-80-010, June, 1980. 189 p, 44 Fig, 18 Tab, 57 Ref, 5 Append.

Descriptors: *Chlorination, *Water treatment, *Residual chlorine, *Potable water, *Bacteria, *Viruses, Reservoirs, Public health, Water conveyance, Shigella, Salmonella, Coliforms, Hydrogen ion concentration, Water temperature, Wastewater pollution.

The protection afforded the water consumer by the maintenance of a chlorine residual in water distribution systems was evaluated in laboratory holding tanks and reservoirs and existing municipal water distribution systems. In the laboratory studies, tap water, adjusted to the appropriate pH, temperature, and chlorine residual, was challenged with varying levels of autoclaved sewage seeded with Shigella, Salmonella, coliforms, poliovirus 1, and f2 bacterial virus. Comparative survivals of these microorganisms were evaluated over two hour periods. As expected microbial inactivation was increased by lower pH, higher temperature, higher initial chlorine concentration, and lower sewage concentration. An initial free chlorine concentration was more effective than an equivalent initial combined chlorine residual. In reservoir studies, where the residual chlorine is replenished by inflow of fresh uncontaminated chlorinated tap water, greater inactivation was observed at the higher sewage concentration levels tested. The maintenance of a free chlorine residual was found to be the single most effective measure for maintaining a low plate count in the distribution system. More than 6000 plate count isolates were studied and classified into functional groups based on seven biochemical characteristics. (Moore-SRC)
W81-04684

**WATER TREATMENT PROCESS MODIFICATIONS FOR TRIHALOMETHANE CONTROL AND ORGANIC SUBSTANCES IN THE OHIO RIVER.**
Ohio River Valley Water Sanitation Commission, Cincinnati.
Environmental Protection Agency Report EPA-600/2-80-028, March, 1980. 306 p, 58 Fig, 157 Tab, 22 Ref, 11 Append.

Descriptors: *Water treatment, *Water treatment facilities, *Chlorination, *Chlorinated hydrocarbons, Utilities, Ammonification, Activated carbon, Water pollution control, Water quality, Trihalomethanes.

Plant-scale studies at seven water utilities using the Ohio, Allegheny, Beaver, and Monongahela Rivers as their source of supply evaluated various water treatment process modifications for both the control of trihalomethane levels and the modifications' impact on bacteriological quality of the finished water. Process modifications studied, based on comprehensive organic analysis, included relocation of the chlorine application point, chlorination/ammoniation, partial or complete substitution of chlorine dioxide for chlorine, and placement of four different types of virgin granular activated carbons in filter beds. Each treatment produced satisfactory reductions in trihalomethanes in the finished water, but the granulated activated carbons were exhausted after periods of 7-15 weeks depending upon the type, the trihalomethane compound, and the location. Supplemental studies included organic analysis of monthly raw and finished water samples collected for a one-year period at each of 11 participating water utilities. (Brambley-SRC)
W81-04687

**APPARATUS FOR DEIONIZING LIQUIDS WITH ION EXCHANGE RESINS,**
H. D. Robison.
U.S. Patent No 4,220,531, 13 p, 5 Fig, 25 Ref; Official Gazette of the United States Patent Office, Vol 998, No 1, p 223-224, September 2, 1980.

Descriptors: *Patents, *Demineralization, *Water treatment, *Water purification, Water quality control, Ion exchange, Resins, Equipment, Flow control, Backwashing, Regeneration.

The invention provides an apparatus for operating primary cation and anion exchange vessels with substantially greater quantities of resin than permitted by prior art designs and methods. This permits a substantial increase in exchange capacity. In addition to being suitable for installation as a complete system, the invention is also well adapted to enable prior art installations to be modified to increase their exchange capacity at minimal cost. A spider-type distributor assembly having integral flow control means is installed in the top head of a resin-containing exchange vessel, to permit resin bed volume to substantially occupy the entire vessel volume, limited only by the inservice swelling characteristics of the resin. An auxilliary vessel, termed the resin drop tank, is provided for receiving a portion of the resin from the exchange vessel to accomplish backwashing of such portion outside the exchange vessel and all or none of the remaining resin inside the exchange vessel before replacing and regenerating the resin. (Sinha-OEIS)
W81-04739

**EFFECTS OF ACTIVATED CARBON AND BACTERIOSTATIC FILTERS ON MICROBIOLOGICAL QUALITY OF DRINKING WATER,**
Health and Welfare Canada, Ottawa (Ontario). Health Protection Branch.
For primary bibliographic entry see Field 5B.
W81-04797

**KEY WEST TAPS THE SEA,**
For primary bibliographic entry see Field 3A.
W81-04814

**OZONE INACTIVATION OF CELL- AND FECAL-ASSOCIATED VIRUSES AND BACTERIA,**
Maine Univ. at Orono.
For primary bibliographic entry see Field 5B.
W81-04844

**COVERING THE OPERATIONAL & HEALTH PROBLEMS ASSOCIATED WITH STORAGE RESERVOIRS,**
For primary bibliographic entry see Field 2H.
W81-04849

**CATCH 22.**
For primary bibliographic entry see Field 5D.
W81-04881

**PHYSICAL MODELS AND PILOT OPERATION IN TREATMENT PLANT DESIGN,**
New South Wales Univ., Kensington (Australia).
For primary bibliographic entry see Field 6A.
W81-04882

**CHLORINE DIOXIDE WATER DISINFECTION: A PROSPECTIVE EPIDEMIOLOGY STUDY,**
Health Effects Research Lab., Cincinnati, OH.
G. E. Michael, R. K. Miday, J. P. Bercz, R. G. Miller, and D. G. Greathouse.
Archives of Environmental Health, Vol 36, No 1, p 20-27, January/February, 1981. 8 Tab, 26 Ref.

Descriptors: *Disinfection, *Water treatment, *Public health, Chlorine, Chlorine dioxide, Epidemiology, Drinking water.

Chlorine dioxide is one of several alternate disinfectants for drinking water currently being investigated which do not produce trihalomethane by-products. There have been no previously reported epidemiological studies of communities served by utilities using chlorine dioxide for water disinfection. The community studied used chlorine dioxide exclusively for disinfection from April to October, and traditional chlorine treatment during the winter months. The study population consisted of 198 persons exposed to the chlorine dioxide and a control population of 118 persons. Pre-exposure hematologic and serum chemical parameters were compared with test results after 115 days of exposure to the chlorine dioxide treated water. Chlorite ion levels in the water averaged approximately 5 ppm during the study period. Statistical analysis of the data failed to identify any significant exposure-related effects. The results of this study suggest that future research of chlorine dioxide disinfection should be focused on high-risk individuals susceptible to oxidant stress, including infants and persons with glucose-6-phosphate deficiencies. (Carroll-FRC)
W81-04908

**GUINEA WORM DISEASE,**
Center for Disease Control, Atlanta, GA.
D. R. Hopkins, and W. H. Foege.
Science, Vol 212, No 4494, p 495, May 1, 1981. 7 Ref.

Descriptors: *Drinking water, *Developing countries, *Human diseases, Parasites, Public health, *Guinea worm disease, Water treatment.

Preference should be given to eradicating Guinea worm disease, drancunculiasis, during the International Drinking Water Supply and Sanitation Decade. The disease is transmitted through drinking water and affects 30 to 40% of the rural farmers and villagers in Africa, India, and the Middle East. Guinea worm is the only disease which can be entirely eliminated by substituting safe drinking water for bad. Within a year after the introduction of safe drinking water, recurrent seasonal infections disappear. The rural population still unserved by safe drinking water in the relevant World Health Organization regions of Africa, Eastern Mediterranean countries, and Southeast Asia is about 786 million, and only 1.3 to 6.2% of the unserved rural populations of these regions need to be reached with safe drinking water to eliminate guinea worm disease. (Small-FRC)
W81-04982

## 5G. Water Quality Control

**INVESTIGATION OF 222RN, 226RA, AND U IN AIR AND GROUNDWATERS OF MAINE,**
Maine Univ. at Orono. Land and Water Resources Center.
For primary bibliographic entry see Field 5A.
W81-04654

**MICROBIAL DEGRADATION OF KEPONE IN THE CHESAPEAKE BAY,**
Maryland Univ., College Park. Dept. of Microbiology.
For primary bibliographic entry see Field 5B.
W81-04657

**USER'S MANUAL FOR PREMINING PLANNING OF EASTERN SURFACE COAL MINING, VOLUME 5: MINE DRAINAGE MANAGEMENT AND MONITORING,**
Pennsylvania State Univ., University Park.
H. L. Lovell, R. Parizek, D. Forsberg, D. Richardson, and A. Weiner.
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-206047, Price codes: A08 in paper copy, A01 in microfiche.
Environmental Protection Agency Report EPA-600/7-81-022, March, 1981. 165 p, 59 Fig, 17 Tab, 130 Ref.

Descriptors: *Coal mining, *Strip mines, *Mine drainage, *Water quality management, *Water pollution prevention, Monitoring, Data acquisition, Planning, Groundwater movement, Wastewater treatment, Wells, Environmental effects, Environmental protection.

This volume is the fifth in a series of six reports designed to provide the surface coal mining industry and its regulators with a comprehensive review of the best available methods for extracting coal while protecting the fragile environment. This volume provides a technical background on which to establish pragmatic guidelines for making decisions regarding water quality management. Planning for mine drainage control begins with the accumulation of data during exploration, which will include information on the coal, overburden, preparation, transport, storage of mined coal, coal preparation refuse disposal, and economic relationships. The approaches to water quality control involve the control of water movement, the nature of the overburden, the control of conditions with water pollution potential during active mining, the use of settling ponds, the treatment of waters to meet effluent standards, and the development of water storage areas as an alternative to direct release. A number of experimental techniques are available for treating surface mine waters. They include: ion exchange; reverse osmosis; use of soil as a renovation medium; application of sewage sludge and effluents; use of limestone barriers; use of water storage areas; use of connector wells to control groundwater; and use of connector wells to dispose of polluted groundwater. Monitoring is required during all phases of mine planning, mining, and restoration and should include measurements of groundwater levels, streamflow, water quality, erosion, siltation, and changes in surface water levels. (Brambley-SRC)
W81-04691

**PROPOSED GEOUND WATER PROTECTION STRATEGY,**
Environmental Protection Agency, Washington, DC. Office of Drinking Water.
Report, November, 1980. 61 p, 2 Tab.

Descriptors: *Water quality control, *Groundwater pollution, *Water pollution control, *Water pollution prevention, Groundwater management, Public health, Public participation, State jurisdiction, Groundwater classification.

There is growing evidence that groundwater, a resource that has always been considered relatively pollution free, is widely contaminated. The nature of that contamination may pose significant public health problems and threaten critical ecological

systems. Given the far-reaching aspects of the problem, this groundwater protection strategy is being developed with broad public debate and participation. The proposed goal for the strategy is to assess, protect, and enhance the quality of groundwater to the levels necessary for current and projected future uses and for the protection of the public health and significant ecological systems. This goal recognizes that all groundwater is not of the same value. The goal is primarily preventive, rather than curative. The management approach proposed in this strategy includes four key elements: state groundwater protection strategies to be developed by the states; groundwater classification; minimum national requirements for selected high priority problems; and EPA administrative action. There are four types of technical requirements which are expected to be used extensively under this strategy: siting practices, best management practices, technology-based or effluent standards, and performance standards. (Moore-SRC)
W81-04700

**SELECT TOPICS IN STORMWATER MANAGEMENT PLANNING FOR NEW RESIDENTIAL DEVELOPMENTS,**
Meta Systems, Inc., Cambridge, MA.
R. Berwick, M. Shapiro, J. Kuhner, D. Luecke, and J. J. Wineman.
Available from the National Technical Information Service, Springfield, VA 22161 as PB80-187479, Price codes: A10 in paper copy, A01 in microfiche. Environmental Protection Agency Report EPA-600/2-80-013, March, 1980. 221 p, 30 Fig, 22 Tab, 86 Ref, 5 Append.

Descriptors: *Storm runoff, *Water pollution control, *Housing, *Model studies, *Mathematical models, *Cost analysis, Roads, Political aspects, Storm water, Construction, Paving, Surface runoff.

It is expected that a substantial proportion of the nation's housing stock in the year 2000 will have been constructed over the next 20 years. The manner in which these new units are designed, constructed, and maintained will be an important factor in the contribution of the residential sector to the nation's environmental quality. Areas of research undertaken in this study included: the evaluation of pollutant accumulation and washoff data; development of production functions for stormwater management measures; formation of single stochastic models for stormwater management; estimation of cost models for control measures; and evaluation of institutional and political problems in implementing non-conventional control measures. Analysis of existing data on street surface accumulation and washoff suggests the modification of functional forms and parameter values in models such as STORM and SWMM. Porous pavement was the single most effective control measure of those considered, but altering subdivision layout was an equally effective approach. Investigation into the institutional aspects of innovative stormwater controls identified several factors as important in the acceptance of innovation: strength of the housing market; professionalism and technical expertise in government; and city size and geographic region. (Moore-SRC)
W81-04701

**RESTORATION OF MEDICAL LAKE,**
JACA Corp., Fort Washington, PA.
Environmental Protection Agency Capsule Report EPA-625/2-80-025, August, 1980. 16 p, 9 Fig, 3 Tab.

Descriptors: *Eutrophic lakes, *Medical Lake, *Washington, *Lake restoration, *Phosphorus removal, *Alum, Chemical precipitation, Chlorophyll, Opacity, Costs, Recreation.

Medical Lake, in eastern Washington State, was eutrophic, and contained 0.3 ppm of phosphorus. The lake has a small drainage area and no surface inputs, so chemical precipitation by alum was selected as the most appropriate and economical restoration method. Laboratory tests indicated that an alum concentration of 150 mg/l, applied as a liquid slurry, was necessary to achieve the required 87% reduction of orthophosphorus. The alum was applied from barges over a period of a month, until 935 metric tons had been applied. Monitoring of phosphorus and chlorophyll concentrations and Secchi disk visibilities throughout the program showed that post-treatment total phosphorus concentrations were below 0.1 ppm, chlorophyll concentrations were reduced significantly, and Secchi disk visibilities improved. The total cost for the program was $239,000 and the lake is now suitable for recreational uses. (Brambly-SRC)
W81-04708

**AN ASSESSMENT OF ECONOMIC BENEFITS OF 28 PROJECTS IN THE SECTION 314 CLEAN LAKES PROGRAM.**
For primary bibliographic entry see Field 6B.
W81-04716

**AN OVERVIEW OF IN-LAKE TREATMENT TECHNIQUES FOR WATER QUALITY MANAGEMENT,**
Illinois State Water Survey, Peoria. Water Quality Section.
For primary bibliographic entry see Field 2H.
W81-04729

**IN-LAKE CONTROL OF NUISANCE VEGETATION: A REVIEW OF EIGHT PROCEDURES,**
Kent State Univ., OH. Dept. of Biological Sciences.
G. D. Cooke.
In: Proceedings of a Round Table on Reclaiming and Managing Lakes in Illinois, October 10-11, 1980. Illinois Institute of Natural Resources, Chicago, Document No 81/06, February, 1981, p 43-55. 20 Ref.

Descriptors: *Lake restoration, *Eutrophication, *Dredging, *Lake sediments, *Algal growth, Eutrophic lakes, Aquatic weeds, Phosphorus removal, Aeration, Precipitation, Sediment control, Rehabilitation.

Several techniques for restoring lakes are known, and each can provide long-term relief from symptoms, following diversion, if properly selected and applied. Eutrophication causes excessive biological production and decreased lake or reservoir volume. Improvement is possible if the sources of plant nutrients and silt are controlled. Following this, both rooted plants and nuisance algae may be limited by restricting light, preventing their growth by physical barriers or cutting, and controlling the recycling of nutrients from storage in lake sediments. Lake restoration cannot treat symptoms alone, but must include land management to control sources of the problem and in-lake manipulations to give long-term control of plant growth. In-lake restoration methods reviewed in this report are: sediment removal (dredging), aquatic plant harvesting, sediment covering to control nutrient release of rooted plant growth, lake level drawdown, aeration/circulation, dilution/flushing, phosphorus precipitation/inactivation, and biological controls. The report concludes that it is possible to prevent eutrophication of real lakes by planning the development before the lake is built, and that most lakes can be restored to a useful condition that reflects the desired activities of its users. An adequate lake management plan may require resources and time, but it will also give lasting control of eutrophication. (Garrison-Omniplan)
W81-04730

**APPARATUS FOR COALESCING,**
Marine Construction and Design Co., Seattle, WA. (Assignee).
J. L. McGrew.
U.S. Patent No 4,220,544, 14 p, 9 Fig, 6 Ref; Official Gazette of the United States Patent Office, Vol 998, No 1, p 227-228, September 2, 1980.

Descriptors: *Patents, *Oil pollution, *Water pollution treatment, *Water quality control, Separation techniques, Coalescence, Immiscibility, Equipment.

In many situations oil pollution of water exists where the oil is dispersed in droplets of such minute size that bulk or stratified oil separation techniques are ineffective. As a process, this invention, applied illustratively to coalescing minute droplets of oil dispersed in water, comprises the steps of first ingesting the mixture liquids into an oleophilic three-dimensioned network or matrix preferably having small open cells or pores predominantly of approximately the same size; secondly holding the ingested mixture in the matrix pore spaces under quiescent (i.e., substantially motionless) conditions for a time period which allows gravity settling of the oil droplets onto the pore surfaces where they will coalesce together with the aid of the oleophilic properties of those surfaces; transporting the ingested mixture to a discharge point preferably during the holding period just described; and finally purging the matrix of the water and coalesced oil at such discharge point. The matrix formed as an endless belt is moved circuitously. The matrix belt or band is of a resiliently compressible open-pore polymeric or similar 'foam' material. Purging it of liquids is accomplished by squeezing. Reexpansion of the matrix as it reenters the body of mixture causes it to ingest more mixture to start another operating cycle. (Sinha-OEIS)
W81-04737

**APPARATUS FOR DEIONIZING LIQUIDS WITH ION EXCHANGE RESINS,**
For primary bibliographic entry see Field 5F.
W81-04739

**METHOD FOR DISINFECTING,**
Sterling Drug Inc., New York. (Assignee).
H. Eggensperger, W. Beilfuss, and W. Zerling.
U.S. Patent No 4,221,660, 5 p, 2 Tab, 7 Ref; Official Gazette of the United States Patent Office, Vol 998, No 2, p 613-614, September 9, 1980.

Descriptors: *Patents, *Water treatment, *Industrial water, *Disinfection, Water purification, Water quality control, Bacteria.

The invention relates to a method for disinfecting aqueous systems contaminated with bacteria and/or fungi, e.g., industrial water circulation systems. It has now been discovered that stable, solid organic percarboxylic acids which have solubility in water not in excess of about 1% are released slowly over a long period of time into aqueous systems with which they are placed in contact, resulting in antimicrobial activity of long duration in such aqueous systems. There is also provided a method for disinfecting a material contaminated with bacteria and/or fungi. When brought into contact with water or an aqueous system to be disinfected, some of the excess solid aromatic percarboxylic acid of the formula disclosed, is dissolved, thus providing efficient disinfection of the water or aqueous system. (Sinha-OEIS)
W81-04749

**SOME CONSIDERATIONS IN THE RESTORATION AND PRESERVATION OF LAKES,**
Illinois State Water Survey, Urbana.
K. P. Singh.
In: Proceedings of a Round Table on Reclaiming and Managing Lakes in Illinois, October 10-11, 1980. Illinois Institute of Natural Resources, Chicago, Document No 81/06, February, 1981. p 21-27.

Descriptors: *Lakes, *Lake restoration, Lake sediments, Water storage, Sediment-water interfaces, Soil erosion, Erosion control, Slope degradation, Structural engineering, Weirs, Dams.

A new strategy is needed to make lakes environmentally more acceptable and physically viable. Lake restoration uses short-term measures for quick results, followed by long-term measures for preservation. Restoration has 3 main categories: revitalizing storage, structural safety, and optimal lake operation. Revitalizing storage can be accomplished either by dredging or by raising the dam. For dredging, equipment, location, and disposal or use of material must be considered. To increase storage by raising the dam, considerations include

dam safety, hydraulic and structural adequacy of spillways and stilling basing, and economical modifications. A structural inspection program must be established. Structural failure can cause a flood peak from 1 to 1.5 times the probable maximum flood (PMF). Failure under PMF conditions can cause a flood wave from 2 to 2.5 times the PMF. Lake preservation can be accomplished by reducing sediment input, improving lake operation to reduce sediment trapped in the lake, reducing shoreline erosion, and improving water quality. The Universal Soil Loss Equation estimates soil loss potential. The actual ratio of sediment inflow to potential soil loss is about 0.25 to 0.30 for five Illinois lakes. Sources of sediment must be determined and erosion controlled. Detention weirs can also reduce sediment. Research is needed regarding the bond between contaminants and soil particles to estimate the probability of separation at various stress levels. Water quality can be improved by installing multi-level intakes to draw off water with higher levels of dissolved oxygen. Shoreline erosion can be reduced by removing submerged vegetation and protection critical areas. (Atkins-Omniplan)
W81-04752

**THE CLEAN LAKES PROGRAM,**
Illinois Environmental Protection Agency, Springfield. Div. of Water Pollution Control.
D. F. Sefton.
In: Proceedings of a Round Table on Reclaiming and Managing Lakes in Illinois, October 10-11, 1980. Illinois Institute of Natural Resources, Chicago, Document No 81/06, February, 1981. p 165-179, 18 Ref, 6 Append.

Descriptors: *Lakes, *Lake classification, Administrative agencies, *Water quality control, Public waters, Cost allocation, Cost sharing, Government supports, Public benefits, Environmental effects, Financial feasibility, Lake restoration, *Illinois.

One goal of the Illinois Environmental Protection Agency (EPA) is a comprehensive program to protect, manage, and reclaim Illinois lakes. In 1977, under the Section 208 Program, 353 lakes were assessed. In 1979, a more quantitative assessment of 64 lakes was undertaken. Sample parameters and preservation/analysis methodologies are provided. The 1980 Ambient Lake Monitoring Program establishes baselines and defines trends in lake water quality, and identifies new or existing problem areas. The pilot Volunteer Lake Monitoring Program will allow citizens to learn about lakes/lake management and also provide baseline information that would not otherwise be gathered, due to limited resources. The Clean Lakes Program determines lake water quality problems, examines alternatives for improving water quality, and implements these alternatives. The USEPA has specific regulations for administering the Program and has established three types of assistance: lake survey and classification, Phase 1 diagnostic/feasibility study, and Phase 2 implementation awards. Awards are for publicly-owned freshwater lakes and are only made to state agencies. Phase 1 awards are up to $100,000 and require a 30% non-federal cost share. Phase 2 awards require a 50% non-federal share. These awards are not contingent upon one another. The Illinois EPA applies for the funds and administers the program. In July 1980, the Illinois EPA received a one-time federal grant of $100,000 (70% federal, 30% state) to develop the state's lake classification and priority ranking. It also received awards for three Phase 1 diagnostic/feasibility study projects in July 1980 totaling $104,650. The program needs public support to succeed. (Atkins-Omniplan)
W81-04761

**ILLINOIS STATE LAKE MANAGEMENT PROGRAM,**
Illinois Dept. of Conservation, Springfield. Div. of Fisheries.
P. J. Paladino.
In: Proceedings of a Round Table on Reclaiming and Managing Lakes in Illinois, October 10-11, 1980. Illinois Institute of Natural Resources, Chicago, Document No 81/06, February, 1981. p 180-190, 3 Fig, 2 Tab, 1 Append.

Descriptors: *Water resources development, *Lakes, *Ponds, *Water management, Water resources institutes, Artificial lakes, Fish populations, Fisheries, Fish management, Research priorities, *Illinois.

The goal of the Illinois State Lake Management Program is the protection, enhancement, and utilization of the State's aquatic life and its habitat. The program is a separate section of the Illinois Department of Conservation (IDOC), Division of Fisheries. The IDOC manages 82,920 lakes and ponds, of which 95% (67% by water acreage) are manmade. The Management Program has four fishery regions which are subdivided into 17 fishery management districts ranging in size from two to eight counties. Water areas are prioritized according to ownership classification. The majority of field management occurs on state and public water and involves intensive monitoring of fish populations, limited aquatic vegetation control, fish harvest estimates, and control of undesirable fish species. Organizational, commercial, and private water users receive limited actual field management; however, a good deal of consultative management is provided annually. The Division of Fisheries has many publications directed toward private pond owners. The Division has also funded research to develop new management capabilities and has been involved with inland lake renewal and watershed management programs. In addition to formal research projects, the State Lake Program conducts a variety of management investigations each year. (Atkins-Omniplan)
W81-04762

**BIOMANIPULATION AND LAKE RESTORATION ON STATE WATERS IN ILLINOIS,**
Illinois Dept. of Conservation, Spring Grove.
G. Erickson.
In: Proceedings of a Round Table on Reclaiming and Managing Lakes in Illinois, October 10-11, 1980. Illinois Institute of Natural Resources, Chicago, Document No 81/06, February, 1981. p 191-195, 1 Ref.

Descriptors: *Fish management, *Lakes, *Fish populations, *Aquatic plants, Aquatic habitats, Lake basins, Rotenone, Rehabilitation, Turbidity, Sedimentation, Eutrophication, Aeration, Particulate matter, Pollutants, *Illinois, *Lake restoration.

Water quality and aquatic habitat are critical in the long-term management of a sports fishery. Most species of fish in a management program are intolerant of low dissolved oxygen, high carbon dioxide, and high turbidity. Water temperature, nutrients, and sunlight affect the primary production of algae---the food supply for these fish. High turbidity caused by bottom feeding fish reduces primary productivity. Use of the fish toxicant rotenone, an organic compound, has resulted in five- to eight-fold improvements in water clarity. Most of the state-owned lakes are manmade and vulnerable to watershed disturbances, such as from row crop farming. Sedimentation affects many trophic levels displacing benthic organisms, forcing out or burying aquatic vegetation, and eliminating forage. Contaminants adhering to silt particles include nutrients, herbicides, insecticides, and heavy metals. Sedimentation usually causes high nutrient levels and excessive biological production, prime conditions for algal blooms, and subsequent fishkills. Aeration allows carbon dioxide to escape, but is only a short-term measure. The Department of Conservation is working with landowners to protect/restore their land. The voluntary Lake Le-Aqua-Na Project involved streambank stabilization and stream corridor fencing for watershed management. The Frank Holton State Park Project is another effort at protection/restoration, half of which ($927,000) is funded by the Clean Lakes Program. Sportfishing is second only to swimming in outdoor recreation in Illinois; therefore, to maintain optimum levels of primary productivity for fish production, it is necessary to maintain productive waters. (Atkins-Omniplan)
W81-04763

**EFFECTS OF DECHLORINATION ON EARLY LIFE STAGES OF STRIPED BASS (MORONE SAXATILIS),**
Academy of Natural Sciences of Philadelphia, Benedict, MD. Benedict Estuarine Research Lab.
L. W. Hall, Jr., D. T. Burton, W. C. Graves, and S. L. Margrey.
Environmental Science and Technology, Vol 15, No 5, p 573-578, May, 1981. 5 Tab, 32 Ref.

Descriptors: Chlorination, *Residual chlorine, *Sulfur dioxide, *Bass, Fish, Juvenile growth state, Estuarine environment, Larvae, Eggs, Fish eggs, Sulfur compounds, Water pollution effects, Toxicity, *Dechlorination, Chlorine.

Sulfur dioxide dechlorination reduced toxicity from residual chlorine to striped bass (Morone saxatilis) at exposure periods less than 36 hours for eggs and less than 96 hours for larvae. These stages of striped bass occur in estuaries where chlorinated industrial effluents are discharged. Mortalities to larvae in estuarine water were as follows: total residual chlorine (concentration 0.06 mg per liter) 96 hours, 75%; (concentration 0.13 to 2.00 mg per liter) 12 hours and less, 100%; sulfur dioxide (concentration 0 to 2 mg per liter) 36 hours, 1 to 10%; 96 hours, 1 to 29%; dechlorinated mixture (zero total residual chlorine with 0 to 2 mg per liter S02) 36 hours, 2 to 7% and 96 hours, 6 to 39%. (Cassar-FRC)
W81-04887

**TECHNOLOGY-BASED EFFLUENT STANDARDS: THE U.S. CASE,**
Bowdin Coll., Brunswick, ME. Dept. of Economics.
A. M. Freeman, III.
Water Resources Research, Vol 16, No 1, p 21-27, February, 1980. 1 Tab, 9 Ref.

Descriptors: *Standards, *Effluents, Water pollution control, Planning, Design standards, Water quality standards, Specifications, Decision making, Management, Administrative decisions.

The use of technology as the basis for setting effluent and emission standards for air and water pollution control is discussed. Technology-based effluent and emission standards refer to quantitative limits placed on all dischargers, where the quantities are determined by reference to the available technology defined in terms of what is practical, possible, or achievable. Procedures used by the EPA in establishing standards, issues involved in their implementation, and the economic consequences of these decisions are considered. Technology based standards are shown to have complexities of their own and to involve difficult judgment about technology, feasibility and the degree to which cost and benefit considerations should influence standard setting. Standards arrrived at through considerations of available technology are not necessarily easier to implement than are other strategies. However, other approaches to environmental policy determinations are also difficult. (Baker-FRC)
W81-04927

**APPLICATION OF PREDATOR-PREY MODELS TO DISINFECTION,**
Rensselaer Polytechnic Inst., Troy, NY.
C. N. Haas.
Journal of the Water Pollution Control Federation, Vol 53, No 3, p 378-386, March, 1981. 2 Fig, 2 Tab, 15 Ref.

Descriptors: *Disinfection, *Mathematical models, *Population dynamics, Kinetics, Predation, Prediction, Chlorination, Water pollution effects.

Previously developed mathematical models of the dynamics of predator-prey relationships assumed batch cultures with predator and prey growth rates and used first order kinetics. Later refinements extended these models to include the case of a complete mix continuous flow culture. This paper discussed the extension of these kinetic models for the case of a batch, or a plug flow, predator-prey system interacting under the influence of an inhibitory compound such as a disinfectant. The assumptions used for model development are presented and the essential features of the model are discussed. The model can be applied to microbial

dynamics in potable water distribution systems under the influence of disinfectant residuals, in wastewater disinfection contactors, in receiving streams under the influence of effluents with no disinfectant residual, and in receiving streams under the influence of effluents containing disinfectant residuals. Application of the model in each of these situations is described. (Carroll-FRC)
W81-04952

# 6. WATER RESOURCES PLANNING

## 6A. Techniques Of Planning

**OPTIMAL MIX OF ADJUSTMENTS TO FLOODS,**
Purdue Univ., Lafayette, IN. School of Industrial Design.
For primary bibliographic entry see Field 4A.
W81-04659

**WATER RESOURCES PLANNING FOR IRRIGATION SYSTEMS,**
Technical Univ. of Prague (Czechoslovakia).
M. Holy, and Z. Kos.
Water Supply and Management, Vol 5, No 2, p 195-200, 1981. 1 Tab, 6 Ref.

Descriptors: *Irrigation design, *Systems analysis, *Water resources development, Optimization, Water demand, Project planning, Agriculture.

The effective planning of water resources for irrigation is possible by applying the methods of systems sciences within the framework of water management systems. Basic factors which must be known are the development of farmland to be serviced and the water demand and utilization. Irrigation is a sub-system of general agricultural production systems and also of water management systems. Models of irrigation systems must consider the impacts of agricultural production and water management. Scientific methods applied in the decision-making process of irrigation systems and the planning of irrigation systems are being developed continuously. Short-term and long-term control must also be planned. Thus, the development of an area, including human, technical, and economic development, must be considered when planning an irrigation system. (Small-FRC)
W81-04782

**PHYSICAL MODELS AND PILOT OPERATION IN TREATMENT PLANT DESIGN,**
New South Wales Univ., Kensington (Australia).
B. W. Gould.
Effluent and Water Treatment Journal, Vol 21, No 2, p 77-79, 81-85, February, 1981. 3 Fig, 1 Tab, 14 Ref.

Descriptors: *Model studies, *Planning, Mathematical models, Hydraulic models, Structural models, Hydrologic models, Analog models, Computer models, Model testing, *Design criteria, *Water treatment facilities.

Models may be used during the design phase of a water treatment plant to choose between differing proposals. Models may also prove helpful in identifying and understanding problems which may have arisen during the operation of a plant. In deciding what type of model to use, the engineer must identify the interplaying factors significant to the need for the study. If the study is one of flow, aerodynamic models may be of use, as they are more convenient to build and have other advantages. In cases where the mathematics are well understood but hard to analyze, an analog model may be used. Hydraulic scale models are used to study problems which would be difficult to solve by theory alone and to check theoretical solutions. Studies concerned with sedimentation problems begin with the selection of material to serve as a substitute sediment that will react similarly in sedimentation, in inducing density currents, in turbulent intermixing, and in concentration velocity relationships. The cost of a model will largely depend on the accuracy to which it is constructed and the scale adopted. In some cases when the time comes for testing, pilot (full-scale) testing will be essential, as some processes in treatment are not judged amenable to testing on a reduced scale model. Three such situations are flocculation in a sludge blanket, shallow depth sedimentation, and filtration using water and floc of the type expected to be present in the prototype. (Baker-FRC)
W81-04882

**RECREATION AND RIVER TYPE: SOCIAL-ENVIRONMENTAL RELATIONSHIPS,**
Vermont Univ., Burlington. School of Natural Resources.
R. E. Manning, and C. P. Ciali.
Environmental Management, Vol 5, No 2, p 109-120, 1981. 4 Fig, 5 Tab, 17 Ref.

Descriptors: *Recreation, *Rivers, River classification, River systems, Public opinion, Attitudes, Management planning, Planning, Environment, Social aspects, Social needs, Vermont.

The relationship between outdoor recreation activity and the resource base upon which it is carried out is only partially understood. Perhaps the least understood aspect of the recreation-resource relationship is knowledge about the way recreationists use and perceive various environmental resource bases. This study examined recreation use on a diverse river system in Vermont in order to test the hypothesis that recreation use patterns vary systematically by river type. River segments were classified into representative river types through application of a two-fold classification system. The first classification factor, generalized geomorphology, defines and groups the dominant resource bases of which the rivers are comprised. The second classification factor, cultural setting, defines the land use and settlement patterns in which each river type is found. Significant differences were found among resulting river types with respect to the nature and intensity of recreation activity, desired use intensity, and user perceived problems and conflicts. Based on these findings, management recommendations were developed for each river type. It is concluded that when both environmental attributes and cultural setting are taken into account, regularities appear with respect to the way in which river resources are used and perceived by recreationists. Further exploration and expansion of such recreation-resource relationships to other activities and environments may hold substantial implications for the allocation and management of outdoor recreation resources. (Carroll-FRC)
W81-04884

**METHODS FOR WATER SUPPLY FORECASTING,**
GKY and Associates, Inc., Alexandria, VA.
For primary bibliographic entry see Field 7B.
W81-04911

**LINEAR DECISION RULE IN RESERVOIR DESIGN AND MANAGEMENT. 6. INCORPORATION OF ECONOMIC EFFICIENCY BENEFITS AND HYDROELECTRIC ENERGY GENERATION,**
Purdue Univ., Lafayette, IN. School of Civil Engineering.
For primary bibliographic entry see Field 8A.
W81-04915

**A SYSTEMS APPROACH TO WATER RESOURCE ALLOCATION IN INTERNATIONAL RIVER BASIN DEVELOPMENT,**
World Bank Group, Washington, DC.
P. J. Stone.
Water Resources Research, Vol 16, No 1, p 1-13, February, 1980. 14 Fig, 19 Ref.

Descriptors: *River basin development, *Systems analysis, Water resources development, Systems engineering, International waters, Planning.

Methodology is presented which will assist in analyzing water resource systems to provide and interpret technical information so that coordinated water resource use in international river basin developments can be achieved. Three important distinguishing features of the international planning environment are identified, and their implications for the structure and content of the proposed analysis approach are described. These features are that nations pursue distinctive, noncomparable, and often multiple development objectives, that nations are limited in their ability to act autonomously, and that development decisions involve a strategic choice to share a common, scarce resource in the presence of both conflicting and mutual interests. The proposed methodology is developed by organizing these planning features within a multilevel decomposition framework designed to guide nations in coordinating their planning decisions. The computational aspects of the proposed methodology are discussed, and resource transformation curves which permit the concise presentation of necessary analytical information are supplied. The proposed methodology is then applied to an example of international iver basin planning. (Baker-FRC)
W81-04921

**MULTIOBJECTIVE OPTIMIZATION IN RIVER BASIN DEVELOPMENT,**
Arizona Univ., Tucson. Dept. of Systems and Industrial Engineering.
L. Duckstein, and S. Opricovic.
Water Resources Research, Vol 16, No 1, p 14-20, February, 1980. 1 Fig, 4 Tab, 29 Ref.

Descriptors: *River basin development, *Optimization, Water resources development, Systems engineering, Planning, Systems analysis, *Cost analysis, Economic aspects, Decision making, Management, Administrative decisions.

A method of multiobjective optimization in water resources is presented which integrates the cost-effectiveness approach and compromise programming and applies it to a case study. Multiobjective optimization consists in trading off noncommensurable objectives within the framework of a complex and dynamic process. Multiobjective optimization is performed at two levels: first, an engineering level which may be labeled a decision-making phase, and second, a managerial level wherein the solution is accepted. The engineering level optimization may be performed by means of a cost-effectiveness approach followed by the application of compromise programming consisting of choosing a compromise solution located as close as possible to an ideal but nonfeasible solution. This combined method is applied as an example to the design of a water resources system in the Central Tisza River Basin, Hungary. The proposed methodology is able to lead to either one of two different decisions resulting from other studies of this area. A brief discussion of possible approaches for reaching the final choice of alternative systems is given. Several approaches are possible for selecting a final alternative, including negotiation between the agencies representing the various objectives. (Baker-FRC)
W81-04928

**ENVIRONMENT,**
Colorado Univ., Boulder. Inst. of Behavioral Science.
G. F. White.
Science, Vol 209, No 4452, p 183-190, July, 1980. 3 Fig, 55 Ref.

Descriptors: *Natural resources, *Environmental quality, Resources development, Resources management, Exploitation, Risks.

Resource management and preservation has been of increasing concern over the past decade, and several new avenues of approach have been developed. In many studies the environment is now being viewed in a holistic framework, with a greater understanding of the interrelatedness of the various segments. A greater degree of attention has been given to life support systems, that is, the health of the land and its associated plants and animals as a basic fact in the preservation of the resource base. The range of choices available to

environmental managers has increased dramatically. The tendency is to rely less on a single technological fix and more on a multiple mix of various adjustments suited to the unique characteristics of each physical, biological, and social configuration has emerged. The assessment of risk has been refined significantly. Methods for monitoring environmental changes have advanced, and there is increasing emphasis on the global network rather than on isolated areas. (Baker-FRC)
W81-04934

**MONETIZING BENEFITS UNDER ALTERNATIVE RIVER RECREATION USE ALLOCATION SYSTEMS,**
Bureau of Land Management, Moab, UT.
For primary bibliographic entry see Field 6D.
W81-04935

## 6B. Evaluation Process

**A CASE HISTORY STUDY TO DOCUMENT THE EFFECTIVENESS OF WATER USE EFFICIENCY RESEARCH,**
New Mexico State Univ., Las Cruces.
For primary bibliographic entry see Field 3F.
W81-04662

**AN ASSESSMENT OF ECONOMIC BENEFITS OF 28 PROJECTS IN THE SECTION 314 CLEAN LAKES PROGRAM.**
Environmental Protection Agency Report EPA 440/5-80-081, September, 1980. 154 p, 1 Fig, 3 Tab, 61 Ref, 3 Append.

Descriptors: *Lake restoration, *Rehabilitation, *Cost-benefit analysis, *Water quality, Recreation, Aesthetics, Public health, Flood control, Lake fisheries, Public opinion, Wildlife, Water pollution control, Eutrophic lakes.

The Clean Lakes Program became a reality on January 6, 1976 with the award of the first grant. From that date through September 30, 1979, the Environmental Protection Agency has awarded 105 grants, totalling $40,097,110, for projects in 37 states. They include 23 classification grants, awarded to states to survey and determine the condition of their publicly owned lakes, and 82 grants to state or local agencies to study and restore specific lakes with serious water quality problems. Benefits were assessed for a 28-project sample drawn from the second group. The 28 projects, involving $15,349,053 in Federal Funds and an approximately equal sum from state and local agencies, are producing benefits in twelve categories: recreation, aesthetics, flood control, economic development, fish and wildlife, agriculture, property value, public health, multiple use (commercial fishing and public water supply), education and research and development, pollutant reduction, and miscellaneous items such as resource recovery and reduced management cost. Many benefits could not be measured in monetary terms, but the present value of those which could be measured is $127,488,500. This represents a return of $8.30 per Federal dollar expended, or $4.15 per total project dollar. The successes of many Clean Lakes projects appear to have been catalysts for other community activities, some closely related to environmental protection and some not. At a time when government spending is under continued public scrutiny, and many programs are looked at with some disfavor, this one seems almost universally popular with participants. (Moore-SRC)
W81-04716

**A REGIONAL ASSESSMENT OF THE ECONOMIC AND ENVIRONMENTAL BENEFITS OF AN IRRIGATION SCHEDULING SERVICE,**
Economics, Statistics and Cooperative Service, Washington, DC. Natural Resources Economics Div.
For primary bibliographic entry see Field 3F.
W81-04722

**OVERVIEWS OF THE ECONOMIC ASPECTS OF RECLAIMING A LAKE,**
Purdue Univ., Lafayette, IN.
W. L. Miller.
In: Proceedings of a Round Table on Reclaiming and Managing Lakes in Illinois, October 10-11, 1980. Illinois Institute of Natural Resources, Chicago, Document No 81/06, February, 1981. p 114-120, 1 Fig, 5 Tab.

Descriptors: *Economic aspects, *Lake restoration, *Watershed management, *Cost-benefit analysis, Rehabilitation, Dredging, Erosin control, Expenditures, Evaluation, Public benefits, Social benefits, Sediment control, *Indiana.

The economic aspects of lake reclamation can be grouped into those which involve economic efficiency and those which involve equity. Economic efficiency analysis includes determining the cost and benefit of dredging and of watershed management, while analysis of the equity of lake reclamation requires determining who pays the cost and who receives the benefit. This report concludes that these two categories need to be explored further because they both impact water quality and storage capacity of lakes. Watershed management practices to reduce soil losses from watersheds include such conservation practices as grass waterways, terraces, drainage structures, sediment basins, channel stabilization, crop rotation, reduction of row crops in the rotation, and minimum tillage operations such as chisel plowing, maintenance of surface residue, strip cropping, and contour farming. Figures are provided showing that the costs to small farmers in the southern part of the state are higher than to larger farmers in northern Indiana. The equity of reclamation will be influenced by the source of funds for conducting management and dredging operations and by the distribution of benefits. Financial support could be provided by local, state or federal government units. Other aspects of equity to determine are: how much of the lake reclamation benefits adjacent land owners who already stand to gain by higher property values, and what income segments of the population are to bear the costs of reclamation. (Garrison-Omniplan)
W81-04756

**A CASE STUDY OF THE ECONOMIC BENEFITS OF RECLAIMING A LAKE: LAKE PARADISE, MATTOON,**
Illinois Univ. at Urbana-Champaign. Water Resources Center.
S. R. Deo.
In: Proceedings of a Round Table on Reclaiming and Managing Lakes in Illinois, October 10/11, 1980. Illinois Institute of Natural Resources, Chicago, Document No 81/06, February, 1981. p 121-125, 1 Tab.

Descriptors: *Lake restoration, *Rehabilitation, *Economic aspects, *Cost-benefits analysis, Estimated benefits, Sediment control, Sediment transport, Water supply, Potassium compounds, Public benefits, Fertilizers, Soil types, Topsoil.

Lake paradise is the main source of water for the city of Mattoon. Removing three feet of sediment from the lake at a local rate of $1.75 per cubic yard would cost about $1.5 million. This includes removing, drying and handling 822,800 cubic yards of sediment. Potential benefits of this project include improved water supply in terms of storage capacity, improved water quality, and reduction in necessary water treatment. Assuming the improvement in water quality reduces the need for treatments of potassium permanganate to three months of the year instead of five, $1.400 could be saved each year. Research is underway to evaluate present and potential recreation benefits at Lake Paradise. The quality of recreation is likely to improve rather than the number of visits to the site. For example, at a $3.00 value per visit and an estimated 100,000 visits, a 10% increase in value as a result of improved water quality would total $30,000 in additional benefits per year. Estimates from other studies show annual recreational benefits for similar lakes to be $35,000-$50,000. The lake sediment itself benefits agricultural and private users, yielding a possible savings in fertilizer costs of 2,500 per year for five years. The sediment can also be sold as topsoil, yielding a one-time benefit of $411,400. Improved water quality and quantity would directly affect property values; at Lake Paradise , where the property around the lake is owned by the city, such effects will appear indirectly. Estimated total benefits from this combination of restoration and management techniques are sizable, and similar plans are suggested for other Illinois reservoirs. (Garrison-Omniplan)
W81-04757

**USES OF DREDGED MATERIAL,**
Army Engineering Waterways Experiment Station, Vicksburg, MS.
T. R. Patin.
In: Proceedngs of a Round Table on Reclaiming and Managing Lakes in Illinois, October 10-11, 1980. Illinois Institute of Natural Resources, Chicago, Document No 81/06, February, 1981, p 126-132.

Descriptors: *Dredging, *Resources management, *Multiobjective planning, *Lake restoration, *Institutional constraints, Economic aspects, Cost-benefit analysis, Technology, Wildlife habitats, Sediment-water interfaces, Sediment transport, Public participation, Soil aggregates, Dredged material uses.

The overall objective of the 5-year (1973-78), $32.5 million federal Dredged Materials Research Program was to develop productive uses of dredged material as a manageable resource. Nonwildlife uses of dredged materials are classified in six categories: industrial/commercial, recreation, agricultural, material transfer, waterway-related, and multiple purpose. Wildlife use categories are marsh development, terrestrial habitat development, and bird island or avian habitat development. This report examines each category and describes the constraints on using dredged material in each of them. The basic constraints on dredged material disposal and/or use are technical; socioeconomic, in which a sponsor's cost may be increased considerably if much land is moved; legal, including federal, state, and local regulations regarding dry or wet materials, site ownership, and land-use regulations; and advance planning needs involving public groups and agencies. Some of the research now being conducted includes the possible use of dredged material to reclaim abandoned stripmines along the Illinois Waterway, and mixing assorted soils and dredged material to raise rye and barley. The conclusion is that productive use of dredged material is not a new idea, that potential new uses now exist, and that unknown uses are possible to match needs with valuable resources. (Garrison-Omniplan)
W81-04758

**AN ECONOMIC ANALYSIS OF THE RECREATIONAL BENEFITS OF WATER QUALITY IMPROVEMENT,**
Wisconsin Univ.-Madison. Dept. of Agricultural Economics.
N. W. Bouwes, Sr.
In: Proceedings of a Round Table on Reclaiming and Managing Lakes in Illinois, October 10-11, 1980. Illinois Institute of Natural Resources, Chicago, Document No 81/06, February, 1981. p 133-152, 1 Fig, 3 Tab, 16 Ref.

Descriptors: *Water resources development, *Economic aspects, *Administrative decisions, *Cost-benefit analysis, *Model studies, Cost analysis, Evaluation, Data interpretation, Decision making, Water quality standards, Dissolved oxygen, Public opinion, Public participation, Water pollution, Waupoca Lake District, *Wisconsin.

Improved water quality can lead to substantial benefits to a community; however, a cost is associated with the achievement of these benefits. An economic model is described for use in determining, for a given water quality project, whether the potential benefits justify the costs. The paper (1) presents a theoretical foundation on which to build an economic analysis; (2) establishes a framework by which water quality can be accounted for in the model; (3) presents a model that includes the essential water quality variable; and (4) advances a method for applying the model in decision-making

stiuations. As part of the model development, objective and subjective perceptions of water quality improvement were studied, using the Lake Condition Index (LCI) as the objective measure. Correlations between LCI results and subjective interview data were low, but the LCI was found to be the more reliable predictor of recreational behavior. The statistical model is designed to (1) determine the resource value of a lake with current water quality, and (2) predict the impact of improved water quality on recreational users. (Mantius-Omniplan)
W81-04759

**RECLAMATION AND RECREATION: THE RESIDENT'S PERSPECTIVE,**
Illinois Univ. at Urbana-Champaign. Dept. of Leisure Studies.
J. Abscher, and . Musser.
In: Proceedings of a Round Table on Reclaiming and Managing Lakes in Illinois, October 10-11, 1980. Illinois Institute of Natural Resources, Chicago, Document No 81/06, February, 1981, p 153-164, 8 Tab, 1 Ref.

Descriptors: *Lakes, *Lake restoration, Public opinion, *Public participation, *Recreation demand, Multiobjective planning, Outdoor recreation, Recreation facilities, Public waters, Economic aspects, Data collection, Water supply, Recreation participation, Water pollution, Cost-benefit analysis, *Illinois, Paradise Lake.

This paper reports some of the preliminary results of an attitude survey concerning the renewal of Lake Paradise near the town of Mattoon, Illinois. In a mailed questionnaire, the residents were asked their attitudes toward water resource projects, various possible renewal objectives, recreation opportunities, environmental education, and funding associated with the project. Respondents showed a strong interest in water quality and quantity, conducting a renewal project at the lake, and the recreational opportunities that would result. There was a strong statement of support for environmental trails and programs at Lake Paradise, and for a combination of taxes and local business/industry involvement to pay for improvements at the lake. The report concludes that recreation is an important aspect of water resource management, but it is often over-simplified in a cost/benefit analysis. It should also be considered as a means to amplify and enhance other social aspects of resource planning which are difficult to quantify, such as quality of life, community pride, and educational opportunity. For example, the proposed golf course received a low desirability rating, while an environmental interpretive center received strong community support. This example underscores the need for public input into recreation planning and the resulting public support for the projects selected. Recreation planning is seen as important both in tailoring recreation opportunities to particular client groups and as a process that builds community involvement, pride, and other intangibles. (Garrison-Omniplan)
W81-04760

**FORWARD STORAGE,**
Instituto Tecnologico Regional de Tijuana, San Ysidro, CA. Centro Regional de Estudios Graduados e Investigacion Tecnologica.
L. DeWitte.
Water Supply and Management, Vol 5, No 2, p 201-217, 1981. 1 Tab.

Descriptors: *Storage, *Hydroelectric power, *Aqueducts, Water conveyance, Pumped storage, Water transport, Energy, Costs, Feasiblity studies, Baja California, Mexico.

Forward storage is a scheme to pump water forward and up hill at higher rates during off-peak hours, provide for summit storage, and generate power on the down slope. Down slope power generation can be done during peak hours. Diurnal and weekend shifts to strictly off-peak pumping necessitates provisions for 24-36 hour forebay and afterbay pondage. In general such forward storage schemes are more economical than the combination of conventional aqueduct operations with pumped storage facilities. Feasibility considerations are presented for forward storage applications to the Sierra de Juarez crossing of the Rio Colorado-Tijuana aqueduct in Northern Baja California, Mexico, and for certain aspects of the Tehachapi crossing of the California aqueduct. Forward storage gives aqueduct planners an additional dimension for overall systems optimization and an opportunity to reduce operating costs. (Small-FRC)
W81-04783

**INFILTRATION/INFLOW REMOVAL,**
Donnelly, Conklin, Phipps and Buzzell, Inc., Springfield, VT.
For primary bibliographic entry see Field 8C.
W81-04835

**INVESTIGATIONS INTO SLUDGE DEWATERING USING POLYELECTROLYTE CONDITIONERS AT BYBROOK SEWAGE-TREATMENT WORKS,**
Southern Water Authority (England). East Kent Div.
C. J. Pulling.
Water Pollution Control, Vol 80, No 1, p 95-101, 1981. 3 Tab.

Descriptors: *Sludge drying, *Polyelectrolytes, *Sludge conditioning, Dewatering, Wastewater treatment, Wastewater facilities, Electrolytes, Lime, Sulfates, Benefits, Economic aspects, *Cost analysis, Great Britain.

The sludge dewatering plant constructed as part of extensions to the Bybrook sewage treatment works in Great Britain is of conventional design for conditioning sludge with lime and copperas. Soon after the plant became functional, a combination of high labor costs, high costs associated with parts replacements, increasing chemical costs, and the general brown appearance of everything that came into contract with copperas made it apparent that alternative conditioning agents should be investigated. Laboratory tests on samples of raw and digested sludge carried out by suppliers of polyelectrolytes showed that Zetag 57 was a suitable conditioner. A pilot-scale run the sludge line produced a satisfactory cake after a four hour period. A series of tests was then conducted to improve the polyelectrolyte conditioning system and to determine the cost effectiveness while using as much of the existing plant as possible. These tests showed that the use of polyelectrolyte as a sludge conditioner resulted in a reduction of chemical costs, a reduction in labor costs associated with the preparation of conditioners, a reduction in corrosion problems, a reduction in power costs, a reduction in the number of press cycles needed to treat a given volume of sludge, increased sludge storage capacity, a reduction of administrative and financing costs, a reduction in maintenance costs, a reduction in the period required for cloth washing, and generally improved appearance of buildings and surrounding areas due to the absence of copperas. The plant can easily be reconverted for conditioning with lime and coopperas if desired. (Carroll-FRC)
W81-04850

**A SYSTEMS APPROACH TO WATER RESOURCE ALLOCATION IN INTERNATIONAL RIVER BASIN DEVELOPMENT,**
World Bank Group, Washington, DC.
For primary bibliographic entry see Field 6A.
W81-04921

**MULTIOBJECTIVE OPTIMIZATION IN RIVER BASIN DEVELOPMENT,**
Arizona Univ., Tucson. Dept. of Systems and Industrial Engineering.
For primary bibliographic entry see Field 6A.
W81-04928

**HEALTH AND RESETTLEMENT CONSEQUENCES AND OPPOTUNITIES CREATED AS A RESULT OF RIVER IMPOUNDMENT IN DEVELOPING COUNTRIES,**
University Coll. of Swansea (Wales). Centre for Development Studies.
C. J. Barrow.
Water Supply and Management, Vol 5, No 2, p 135-150, 1981. 1 Tab, 91 Ref.

Descriptors: *Artificial lakes, *Public health, *Social impact, *Developing countries, Lakes, Social adjustment, Human diseases, Project planning.

The health impacts and social consequences of man-made lakes are discussed for developing countries. Short-term health impacts can be caused by construction, resettlement, and population movement. Schistosomiasis, a disease associated with stabilization of flow, infects 300 million people in 71 sub-tropical and tropical cuntries. Impoundment may favor the incidence of mosquitoes, blackflies, and tsetse flies. Long-term health problems associated with river development include transmission of disease due to weed growth, consumption of still water fish infested with liver-flukes, and population concentrations which can result in rodent infestations and associated diseases. Resettlement is one of the least satisfactory and most costly aspects of creating man-made lakes. It tends to be hurried and beset by administraive and financial problems. Organized resettlement and self-managed resettlement are two approaches. Heavy losses of stock and excessive separation from work may result from resettlement. Before a cam is constructed, a detailed stud should be made of current conditions and possible health and social problems. The public must be cosulted before, during and after planning stages. (Small-FRC)
W81-04968

## 6C. Cost Allocation, Cost Sharing, Pricing/Repayment

**FUNDING ASPECTS OF LAKE MANAGEMENT,**
Illinois Dept. of Commerce and Community Affairs, Springfield.
R. Burd.
In: Proceedings of a Round Table on Reclaiming and Managing Lakes in Illinois, October 10-11, 1980. Illinois Institute of Natural Resources, Chicago. Document No 81/06, February, 1981. p 98-105, 1 Append.

Descriptors: *Economic aspects, *Financing, *Water costs, *Revenues, *Taxes, Grants, User charges, Bond issues, Tax rates, Political aspects, Federal jurisdiction, State jurisdiction, Local governments, Lake basins, Lakes, *Lake management.

In most cases, a publicly owned lake is controlled by one of the following government entities: a city or village, county, township, water commission, public water district, water authority, surface water protection district, river conservancy district, soil and water conservation district, sanitary district, or conservation district. The sources of revenue available to these government entities can be grouped into four basic categories: user charges, bonds, taxes, and state/federal aid. There are considerable differences in financial resources available to each entity. This report describes each of these revenue sources and concludes that: (1) The concept of user charges---requiring those who benefit from the use of a service to pay for it---is gaining increasing interest from local governments across the country. (2) the advantages of revenue bonds are that they are not included within the statutory debt limit of governmental body, and can usually be issued by the government without a referendum. (3) the disadvantages of general obligation bonds are that a referendum is required before issue, and the bonds are included in the statutory debt limit. (4)Property taxes may be possible after a public education campaign for given projects, although they are the least tolerated of all local revenues. (5) Grants entail prohibitively stiff competition. (Garrison-Omniplan)
W81-04753

**OVERVIEWS OF THE ECONOMIC ASPECTS OF RECLAIMING A LAKE,**

Purdue Univ., Lafayette, IN.
*For primary bibliographic entry see Field 6B.*
W81-04756

**IMPLICATIONS OF A DIRECTIVE ON EFFLUENT CHARGES,**
R. Bidwell.
Effluent and Water Treatment Journal, Vol 21, No 2, p 86-88, 90, 92, 93, February, 1981. 4 Fig, 1 Ref.

Descriptors: *Effluent charges, *Cost sharing, Economic aspects, Costs, Cost allocation, Effluents, User charges, Sewage charge.

The effects of introducing into Great Britain a system whereby the polluter pays a effluent charge are explored. There are four major types of charges that might be levied: effluent treatment charges, where the aim is to recover part or all of the cost of treatment; pollution charges levied on direct discharges, perhaps for the purpose of water pollution control; a combination of the aforementioned types; and property charges to aid in paying for the water pollution control facilities and services. Some charges are distributed among the dischargers at an equitable rate, and others are employed as part of an incentive program where the more pollutant free the discharge, the lower the rate charged. In Germany the Ruhrverband system, a cooperative in Nordrhein Westphalia which incorporates all discharges, including municipalities, has been established. Types of charge systems employed in Germany, the Netherlands and France are also cited. (Baker-FRC)
W81-04877

**SHORT- AND LONG-RUN EFFECTS OF PRICE ON MUNICIPAL WATER USE,**
Dartmouth Coll., Hanover, NH.
*P. H. Carver.*
Water Resources Research, Vol 16, No 4, p 609-616, August, 1980. 3 Tab, 24 Ref.

Descriptors: *Pricing, *Municipal water, *Water use, Water demand, Policies, Seasonal, Elasticity of demand, *District of Columbia.

A study of short run (1-2 years) and long run responses to changes in water prices was done in the Washington, DC., metropolitan area. The data were fitted to a flow adjustment model of the Nerlove (1958) type. The short-run elasticity for aggregate annual water use was less than 0.1 in absolute value, and long run elasticity was within the range of results reported in previous work. When water use was separated into seasonal and nonseasonal components, the elasticities for the seasonal components were smaller (more inelastic) than previously reported for both short and long run. (Cassar-FRC)
W81-04914

**COMPETITION VERSUS OPTIMAL CONTROL IN GROUNDWATER PUMPING,**
New Mexico Univ., Albuquerque. Dept. of Economics.
M. Gisser, and D. A. Sanchez.
Water Resources Research, Vol 16, No 4, p638-642, August, 1980. 1 Fig, 1 Tab, 15 Ref.

Descriptors: *Groundwater management, *Water allocation, *Irrigation, Model studies, Mathematical models, Economic aspects, Pricing, *Water policy, Aquifers, Storage capacity, Agriculture, Water rights.

This paper compares the results of a free market approach with optimal control of groundwater pumping for irrigation. Using the Pecos Basin, New Mexico, as an example, mathematical analysis shows that the two strategies perform equally well if the storage capacity of the aquifer is relatively large. The free market approach assumes that only land overlying the aquifer can be irrigated. In the case of an aquifer with a bottom, junior water rights must be called or all water rights should be restricted. A deterministic model was chosen because natural recharge is small in relation to the storage capacity of the aquifer. (Cassar-FRC)
W81-04916

## 6D. Water Demand

**MONETIZING BENEFITS UNDER ALTERNATIVE RIVER RECREATION USE ALLOCATION SYSTEMS,**
Bureau of Land Management, Moab, UT.
*J. B. Loomis.*
Water Resources Research, Vol 16, No 1, p 28-32, February, 1980. 1 Fig, 17 Ref.

Descriptors: *River systems, *Recreation demand, Recreation wastes, Management, Planning, Decision making, Administrative decisions, Cost-benefit analysis.

When demand to use a river exceeds its ecological carrying capacity, an allocation system must be implemented to ration available permits. This paper examines the equity versus efficiency issues in rationing an ecologically based capacity whose optimum is determined by the intersection of a marginal ecological damage function from impacts of visitor use and the demand for use curve. The model was developed for the study by first estimating the demand to float Westwater Canyon, derived from a modified travel cost model. Recreational benefits of $6,500 under a hypothetical capacity of 50 trips, when pricing was used to allocate the permits, and a range of benefits from as low as $880 to an expected value of 3,690 if a lottery system is used, were estimated using this model. The monetization of the efficiency losses associated with more equitable allocation systems allows managers to be more objective in making the equity-efficiency trade-offs involved in picking a recreation use allocation system. (Baker-FRC)
W81-04935

## 6E. Water Law and Institutions

**ENVIRONMENTAL REGULATIONS AND TECHNOLOGY; THE ELECTROPLATING INDUSTRY.**
Environmental Protection Agency, Washington, DC. Standards, Effluents Guidelines Div.
Report EPA-625/10-80-001, August, 1980. 48 p, 16 Fig, 13 Tab, 38 Ref.

Descriptors: *Electroplating, *Metal-finishing wastes, *Environmental protection, *Regulations, *Heavy metals, Water pollution prevention, Wastewater treatment, Waste recovery, Water reuse, Cost-benefit analysis, Sludge drying, Sludge disposal, Financing.

The EPA has the responsibility for implementing water pollution and solid waste laws which were passed at different times. This report is intended to provide the electroplating industry with a summary of the laws and EPA regulatory activities, and of regulations and technologies that can affect electroplaters' decisions for wastewater pollution control and solid waste handling and disposal. The most important laws are the Clean Water Act of 1977 and the Resource Conservation and Recovery Act of 1976. Resource recovery from waste streams allows reuse of plating materials and water, and may be accomplished by evaporation, reverse osmosis, and electrodialysis. Conventional wastewater treatment consists of chromium reduction, cyanide oxidation, neutralization, clarification, and gravity thickening. Alternative treatments, for cases when metals will not precipitate out, or when more stringent controls are applied, include integrated treatment, sulfide precipitation, and other cyanide oxidation treatments. Five case histories of actual installations, including costs are presented. After wastewater treatment, the sludge which remains must be treated prior to disposal. Dewatering the sludge by vacuum, pressure or compression filters, and centrifuging are used to produce a sludge suitable for land disposal. Sources of financing available to ease the burden of compliance with the regulations are identified. (Brambley-SRC)
W81-04712

**PLANNING WASTEWATER MANAGEMENT FACILITIES FOR SMALL COMMUNITIES,**
Urban Systems Research and Engineering, Inc., Cambridge, MA.
P. L. Deese, and J. F. Hudson.
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-111064, Price codes: A08 in paper copy, A01 in microfiche. Environmental Protection Agency Report EPA-600/8-80-030, August, 1980. 158 p, 56 Fig, 3 Append.

Descriptors: *Wastewater management, *Wastewater facilities, *Rural areas, Economic feasibility, Cost analysis, Social aspects, Regulations, Project planning.

With passage of the Water Pollution Control Act Amendments of 1977, greater emphasis has been placed on consideration of less costly, decentralized wastewater handling technologies for rural communities. Although widespread utilization and extensive research have demonstrated the technical and economic feasibility of such alternatives, little guidance has been available to engineers and planners faced with integrating such technologies into the facility planning process. This manual provides a stepwise procedure for screening and selection of low-cost technologies appropriate for rural and urbanizing areas, where construction of conventional centralized treatment works may have a potentially detrimental impact on the socioeconomic structure of the community. Choosing the right system requires a detailed understanding of the local problems and careful planning of the facilities to solve those specific problems. In essence, this is a guide to performing the first stage (Step 1) under then EPA Municipal Construction Grants Program. Part 1 of the manual was prepared to give an overview of the planning process and the regulatory context under which it fits, and is likely to be useful for local officials, concerned citizens, and engineers active in wastewater planning. Part 2 is a technical reference, showing the details of the planning process with examples from case studies. (Moore-SRC)
W81-04713

**DRAFT, WQM NEEDS ASSESSMENT, FY 80-84.**
Environmental Protection Agency, Washington, DC. Water Planning Div.
Report, September, 1980. 151 p, 42 Fig, 44 Tab.

Descriptors: *Water quality management, *Legislation, *Regulations, *Predictions, *Federal jurisdiction, *State jurisdiction, Water treatment facilities, Nonpoint pollution sources, Groundwater, Monitoring, Water quality standards, Taxes.

This report presents the results of a Water Quality Management needs assessment undertaken to identify the fiscal and manpower resources required by state, interstate, and areawide agencies to protect water quality and achieve the goals of the Clean Water Act. It is based on conservative estimates of activities supported under Sections 106, 208, and 314 which these agencies believe necessary over the next four years to implement the act. The agencies project that an increase of 40% or $85 million above FY 80 total WQM Agency/Federal funding levels will be required by FY 84, but the sources of this funding are not clear. Areas of water quality management covered by the Clean Water Act, and for which projections are presented include: municipal facilities planning and management; industrial and municipal control; nonpoint source planning and administration; urban nonpoint sources; ground water; and other (ambient monitoring, water quality standards, total maximum daily loads and waste load allocations, emergency response, and other state programs). States are operating on a common scenario of increasing demands, constant or decreasing revenue, no expectation of sufficient funds availability to satisfy the requirements of the Clean Water Act, and a reluctance or inability to estimate fully their funding and personnel needs until regulations and policy are more clear. (Brambley-SRC)
W81-04720

**MUNICIPAL WASTEWATER CONTROL TECHNOLOGY RESEARCH STRATEGY 1980-1984.**

Environmental Protection Agency, Washington, DC.
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-189342, Price codes: A07 in paper copy, A01 in microfiche. Report EPA-600/9-80-055, December, 1980. 146 p, 4 Fig, 29 Tab, 2 Ref, 3 Append.

Descriptors: *Municipal wastewater, *Research priorities, *Regulations, *Technology, *Sludge disposal, *Wastewater management, Conservation, Public health, Toxicity, Pollutants, Land disposal, Aquaculture, Urban runoff, Water reuse, Water pollution control.

This program is designed to provide the technology and science support to the Agency offices (program offices) that implement the regulatory aspects of the applicable legislation. This document identifies the requirements for research and development support of program office activities and summarizes how the Office of Research and Development is responding or intends to respond to the identified requirements. Five areas of highest priority research are identified as follows: support in the implementation of the Innovative and Alternative Technology program; resolution of health issues and development of the control technology necessary to recommend environmentally acceptable management methods for municipal wastewater sludges; type, fate, and means of controlling the discharge of toxic pollutants to the urban environment; support and continued development of new or improved on-site wastewater management systems; and development and demonstration of technologies aimed at energy recovery and conservation. The Clean Water Act requires research to be conducted on wastewater process development, toxic pollutants control, municipal sludge management, plant operation and design, land application of wastewater and aquaculture, urban runoff, conservation and reuse, small wastewater flows, innovative and alternative technology, and health effects, and the research requirements, priorities and future directions for each are outlined. (Brambley-SRC)
W81-04721

**LEGAL ASPECTS OF RECLAIMING LAKES,**
Illinois State Dept. of Transportation, Springfield. Div. of Water Resources.
D. R. Boyce.
In: Proceedings of a Round Table on Reclaiming and Managing Lakes in Illinois, October 10-11, 1980. Illinois Institute of Natural Resources, Chicago, Document No 81/06, February, 1981, p 60-63.

Descriptors: *Lake restoration, *Dredging, *Legal aspects, *Permits, Lake sediments, Flood protection, Ecosystems, Detritus, Waterways, Eutrophic lakes, Jurisdiction, Watercourses, Water quality control.

There are three regulatory agencies from which one may need approval for lake restoration by dredging: the Illinois Department of Transportation (IDOT), Division of Water Resources; the Illinois Environmental Protection Agency (IEPA); and the U.S. Army Corps of Engineers. In addition to these, input and comments are generally provided by other state and federal agencies, such as the Illinois Department of Conservation and the U.S. Fish and Wildlife Service. This paper describes the permit authority and procedures of IDOT's division of Water Resources and the permit requirements of the other two agencies. IDOT's regulatory program is based on three fundamental principles: (1) protection of public waters against wrongful encroachment or violation of the public interest; (2) prevention of flood damage; and (3) preservation of the natural condition of the state's rivers, lakes, and streams. Lake dredging, per se, requires a permit from IDOT only if dredging is proposed from a public body of water. A prmit may also be required for deposition of the dredged material, depending on where it is to be placed. Upon receipt of an application for a permit for dredging and/or dredged material disposal, IDOT issues a public notice to government agencies, local officials, and adjacent property owners, and reviews the proposal. The three agencies coordinate their regulatory functions as much as posible. (Garrison-Omniplan)
W81-04732

**INSTITUTIONS FOR LAKE MANAGEMENT,**
Illinois Univ. at Urbana-Champaign. Dept. of Agricultural Economics.
M. R. Grossman, and D. L. Uchtmann.
In: Proceedings of a Round Table on Reclaiming and Managing Lakes in Illinois, October 10-11, 1980. Illinois Institute of Natural Resources, Chicago, Document No 81/06, February, 1981, p 87-97. 14 Ref.

Descriptors: *Lake restoration, *Jurisdiction, *Institutions, *Lake rehabilitation, *Community development, State jurisdiction, Federal jurisdiction, Local governments, Enforcement, Political aspects, Organizations, Legal aspects.

Preventive measures and restoration techniques for lake management and reclamation can be accomplished only through institutions, such as private associations, units of government, or special districts with appropriate powers. This paper focuses on small, private lakes and the two types of institutions most effective in managing them. Homeowners associations can be effective because when they are created---usually when a developer plans a new subdivision involving a lake---they are granted extensive and specially designed powers, including that of assessing levies. Their effectiveness is improved when the association leadership maintains high visibility in the residential area, and when there is a flexible process of enforcement varying between the restrictive covenants on the one hand and the readily amended bylaws of the association on the other. Other already-functioning institutions, authorized by statute, can also be effective, particularly in cases of activities from outside a subdivision. These institutions include federal, state, and local government entities and such agencies as conservation districts, drainage districts, forest preserve districts, park districts, river conservancy districts, municipal and rural sanitary districts, soil and water conservation districts, surface water protection districts, water authorities, and water service districts. The soil and water conservation district has important powers necessary to reduce lake sedimentation. (Garrison-Omniplan)
W81-04736

**CONSERVATION DISTRICT LAW: CHOICES AND CHALLENGES FOR WISCONSIN'S FUTURE,**
Wisconsin Univ. - Extension, Stevens Point. Dept. of Community Affairs.
D. G. Last.
Journal of Soil and Water Conservation, Vol 36, No 2, p 94-96, March/April, 1981.

Descriptors: *Soil conservation, *Water conservation, *State jurisdiction, Legal aspects, Resources management, Soil erosion, *Wisconsin.

Wisconsin's system of Soil and Water Conservation Districts has undergone two comprehensive analyses, and possible future changes to the system are discussed. Erosion control and the management of nonnavigable surface water have been the responsibilities of these districts since 1937. The current need for soil and water conservation programs is great. A recent study indicated that soil erosion control is needed on 60% of the crop land in the state. Specific criticisms of the SWCD include that because it is a special-purpose unit of government, there results a lack of identity, reduced political accountability, and fragmentation of authority. Lack of direct taxing power is also a weakness. One proposed change is that an SWCD be maintained in every county with representative for the county board's zoning, forestry, parks, and solid waste committees as advisors. SWCD's may be more effective if they could initiate regulatory programs in addition to their traditional incentive-based and educational efforts. (Small-FRC)
W81-04773

**ORIGIN AND GROWTH OF FEDERAL RESERVED WATER RIGHTS,**
Nevada Univ. Systems, Reno. Dept. of Civil Engineering.
J. W. Bird.
Journal of the Irrigation and Drainage Division, Proceedings of the American Society of Civil Engineers, Vol 107, No IR1, p 11-24, March, 1981. 40 Ref.

Descriptors: *Water rights, *Federal jurisdiction, *Water policy, Legal aspects, Water law, Reservation doctrine, History, Water allocation, Water resources development, Navigable waters, Flood control.

The Federal government retains control over water rights in large tracts of land, especially in the western U.S. These reserved rights are senior to state or municipal rights and are reserved by law or by implication in Federal treaties, reservations, acts, or actions. The Constitution is the source of these rights, particularly Article 1, Section 8, the commerce clause, and Article IV, Section 3, the property clause. Federal action concerns navigable waters and flood control projects. The courts have developed a system of Federal reserved water rights starting about 1850 and continuing to the present. In the absence of specific federal laws on water rights the newly formed states and territories developed state water rights during the 19th century. In 1899 the navigable waters policy was liberalized to include the non-navigable Rio Grande River on the grounds that a proposed dam might affect the flow of water in the lower river. The Winters Case in Montana (1908) decision held that the Indians on the Fort Belknap reservation were entitled to sufficient water for their irrigation needs, even though the original treaty did not mention water rights. This reserved rights doctrine applies to all Indian reservations. Other cases discussed are the Arizona vs. California (1963), the Pelton Dam, Oregon (1955), and the Devil's Hole National Park Pupfish case (1974). An awareness of the Federal reserved water rights is necessary for those involved in state water resources planning and allocation. (Cassar-FRC)
W81-04802

**POWER PLANT COOLING SYSTEMS: POLICY ALTERNATIVES,**
Consumers Power Co., Jackson, MI.
J. Z. Reynolds.
Science, Vol 207, No 4429, p 367-372, January 25, 1980. 1 Fig, 33 Ref.

Descriptors: *Cooling water, *Powerplants, *Environmental effects, Cooling towers, Electric powerplants, Entrainment, Ecological effects, Water pollution control, Design criteria, Ecosystems, Legislation, Environmental protection, Thermal stress, Temperature effects.

The 1972 Amendments to the Federal Water Pollution Control Act included provisions to deal with the effects on aquatic life that may be caused by the cooling systems of power plants. These amendments favor the installation of cooling towers or closed-cycle cooling systems. In general, alternative cooling system designs resulted in more and greater adverse environmental effects, which were more likely to be irreversible. Evaluations showed that the environmental damages associated with once-through cooling and cooling reservoirs are mostly ameable to mitigation with respect to principles of resource management. These findings, when considered with the greater costs of cooling towers, indicate that once-through cooling systems or cooling reservoirs are preferable over alternative cooling systems when feasibility and minimal risk to aquatic ecosystems are demonstrated. (Geiger-FRC)
W81-04826

**IN-STREAM USE APPROPRIATION APPLICATION PRECLUDED,**
J. Jasperse.
Natural Resources Journal, Vol 20, No 1, p 156-162, January, 1980. 26 Ref.

Descriptors: *Instream flow, *Water allocation, *Water rights, Judicial decisions, Water law, Appropriation, California, Stream fisheries, *Anadromous fish, Redwood Creek, Flow control.

The California Trout, Inc. v. State Water Resources Control Board decision precludes private parties from making in-stream use appropriation applications. California Trout, Inc. sought to appropriate a minimum flow in Redwood Creek (Marin County) to maintain a suitable habitat for juvenile anadromous fish. The California Court of Appeal for the Third District which made the final decision pointed out that California Trout, Inc. failed to meet statutory requirements and showed no legally recognized appropriation of water. The elements necessary for a valid application are: (1) intent to apply the water to beneficial use, (2) actual diversion from the natural channel, and (3) application of the water within a reasonable time to some beneficial use. In-stream use is recognized as a legitimate means by which the state may preserve recreation, fish, and wildlife resources, but a private party may not assert such a use. (Small-FRC)
W81-04829

**CHEMICAL PASSPORTS, ACID RAIN AND THE NEED FOR SCIENTIFIC CREDIBILITY,**
J. Roberts.
Water an Pollution Control, Vol 118, No 8, p 26-28, August, 1980.

Descriptors: *Conferences, *Water pollution control, Acid rain, Fallout, *International agreements, *Great Lakes, Canada, United States.

Several important policy statements were made during an address by the Minister of the Environmental and Science and Technology Minister at the International Association on Water Pollution. Steps that have been made in improving the conditions in the Great Lakes area were noted. Agreements between Canada and the United States concerning water pollution control and monitoring are cited. The wait-and-see attitude cannot be taken regarding such critical issues as the acid rain problem. Efforts underway in Canada to attack this problem are noted. A call is made to the American people to realize the problems involved with acid rain and demand suitable action by taken by the governmental bodies. The need for further and continued research in the many areas of environmental pollution control and especially water pollution control is emphasized. (Baker-FRC)
W81-04851

**WATER LABORATORY CERTIFICATION,**
California State Dept. of Health, Berkeley.
For primary bibliographic entry see Field 5A.
W81-04892

**THE NEW HAZARDOUS WASTE MANAGEMENT SYSTEM: REGULATION OF WASTES OR WASTED REGULATION,**
S. I. Friedland.
Harvard Environmental Law Review, Vol 5, No 1, p 89-129, 1981. 326 Ref.

Descriptors: *Hazardous materials, *Waste management, *Legal aspects, Federal jurisdiction, Regulations, State jurisdiction, Public policy, Waste dumps, Landfills, Public health, Toxicity, Love Canal, Water pollution sources.

In order to protect human health and the environment, the Resource Conservation and Recovery Act of 1976 (RCRA) directed the U.S. Environmental Protection Agency (EPA) to establish regulations for a national hazardous waste management system. EPA developed regulations on hazardous waste management under this Act in 1980. This article explains and clarifies both the Act and the implementing regulations and analyzes their significant features. A summary of the environmental and human health problems which have resulted from the unsound management of hazardous wastes is presented, using the Love Canal disaster as the primary illustration. Existing State hazardous waste controls are discussed and the need for Federal controls is examined. A brief overview of the RCRA and the EPA regulations is presented. Major provisions of the regulations are then described in detail. Significant deficiencies in these regulations are discussed, and possible improvements are suggested. It is concluded that EPA essentially followed a strategy of deferred regulation in developing the new hazardous waste management system and avoided aggressive implementation of the Act. The inadequacies of the identification and listing process, the interim status/standards provisions, and the small quantity generator, domestic sewage, and reuse/recycle exemptions allow these dangerous wastes to escape comprehensive regulation. The promise of future regulation cannot provide short-term relief from the problem of improper disposal of hazardous wastes. (Carroll-FRC)
W81-04899

**MARKETABLE PERMITS FOR THE CONTROL OF PHOSPHORUS EFFLUENT INTO LAKE MICHIGAN,**
Wisconsin Univ.-Madison. Dept. of Economics.
For primary bibliographic entry see Field 5D.
W81-04910

**TECHNOLOGY-BASED EFFLUENT STANDARDS: THE U.S. CASE,**
Bowdin Coll., Brunswick, ME. Dept. of Economics.
For primary bibliographic entry see Field 5G.
W81-04927

**CLEARING THE MUDDIED WATERS,**
S. K. Bowman.
Natural Resources Journal, Vol 20, No 1, p 179-185, 1980. 21 Ref.

Descriptors: *Water rights, *Water law, *Silt load, Suspended load, Water allocation, Irrigation ditches, Irrigation operation, Ditches, Water resources development, *Colorado.

The Bessemer Irrigating Ditch Company, the owner of decreed water rights to divert and use water from a natural stream, sued when a government project resulted in the replacement of silty Arkansas River water with clear reservoir water. The clear water leaked through the bottom of the ditch in greater quantity than the silty water, because the silt tended to seal the bed and banks of the ditch. The clear water also increased erosion and vegetation growth in the ditch. The colorado Supreme Court found that the natural and popular meaning of the work 'water' did not include the silt content. Thus, it concluded that Bessemer had no right to the silt content of its appropriated water. It also found that Bessemer's use of leaky ditches constituted less than maximum utilization of its appropriated water. The majority opinion felt that the maximum utilization doctrine should be integrated into the law of vested rights. The delivery of the silt-free water means the user must either improve the efficiency of his system or bear the losses sustained through increased leakage of his earthen ditches. Because of the close division of the court on this issue and a strong dissenting opinion, the question will probably be raised again in the Colorado courts. (Small-FRC)
W81-04943

**FRUSTRATED ASPIRATIONS FOR WATERSHED QUALITY MANAGEMENT,**
E. J. Cleary.
Journal of the Water Pollution Control Federation, Vol 53, No 3, p 291-298, March, 1981. 22 Ref.

Descriptors: *Political aspects, *Watershed management, *Water quality management, Water pollution control, River basins, Management planning, State jurisdiction, Regional planning, Federal jurisdiction, Water quality standards.

The inability of state regulatory agencies to effectively control water pollution led to advocacy of the creation of watershed management agencies as early as the 1930s. However, political considerations led instead to the increasing concentration of pollution abatement regulatory powers at the Federal lvel. The present U.S. water pollution control program emphasizes the enforcement of uniform, technology-based effluent standards which fail to take into account conditions particular to individual river basins or lacal and regional needs. Watershed agencies offer a great potential for more efficient administration of pollution abatement. Such agencies have been proposed at various governmental levels since 1936. The Delaware River Basin Commission, created in 1961, is the only interstate watershed agency in the United States endowed with the power to finance, design, construct, and operate facilities. Some smaller intrastate watershed agencies are charged with comprehensive planning, financing, and construction an operation responsibilities with respect to pollution control. Drainage basin administration has been instituted by several European countries as the preferred method of water pollution control. Imposition of arbitrary treatment requirements applied uniformly to all wastewater discharges ignores the diversity of physical factors and hydrological conditions distinguishing individual drainage basins and limits local pollution control strategy options. Advances in the methodology for determining the causes, nature, and scope of water quality degradation and demonstrable economic justification for the consideration of a range of technical options and operational tactics to mitigate pollution effects support the premise that watershed management agencies would provide a more effective and responsive system for water quality management than does centralized Federal regulation. In addition, the institutional framework of several existing watershed entities suggests that they could easily be adapted to the exercise of water quality management functions. (Carroll-FRC)
W81-04957

**HYDRO AT AN EBB IN YUGOSLAVIA.**
International Water Power and Dam Construction, Vol 33, No 3, p 47, 50, March, 1981. 1 Tab.

Descriptors: *Hydroelectric plants, *Construction, *Yugoslavia, Powerplants, Economic aspects, Political aspects, Social aspects, Planning.

For several political, economic, and social reasons, progress in hydroelectric development in Yugoslavia is presently very slow. A plant on the Danube, scheduled for completion in 1982, has been delayed. A few small projects are scheduled in the economically advantaged north, and therefore will not help to correct the country's north-south economic imbalance. These projects are either slowed or not yet started. One project, shared with several other countries, is underway on the River Tisza at Novi Becej, Hungary, but only 7% of this river lies within Yugoslavia. (Cassar-FRC)
W81-04988

**HYDROPOWER DEVELOPMENT IN INDIA,**
National Hydroelectric Power Corp., Delhi (India).
T. V. Jeganathan.
International Water Power and Dam Construction, Vol 33, No 3, p 43-46, March, 1981. 3 Fig, 2 Tab.

Descriptors: *Hydroelectric plants, *Long-term planning, *Water resources development, *India, Planning, Powerplants, Himalaya Mountains.

Hydroelectric power will provide about 1/3 of India's installed electric capacity by 1984. In 1979 10,820 MW of the total 26,000 MW capacity was hydropower. Future power generation will emphasize coal, solar, and nuclear power to reduce the probable interstate water conflicts. Nevertheless, several major hydro projects have been commissioned (4500 MW out of a total additional capacity of 1800 MW). A map depicts the major existing and under-construction dams in India. Future exploitation will likely be in the underdeveloped Himalayas. (Cassar-FRC)
W81-04989

## 6F. Nonstructural Alternatives

**FLOOD RISKS AND THE WILLINGNESS TO PURCHASE FLOOD INSURANCE,**
Geological Survey, Lakewood, CO.
M. R. Karlinger, and E. D. Attanasi.

Water Resources Research, Vol 16, No 4, p 617-622, August, 1980.

Descriptors: *Insurance, *Flood damage, *Risks, Simulation analysis.

The effects of alternative insurance schemes on how individuals respond to changes in flood risks were simulated by computer. The two plans were: coinsurance, in which a fraction of the loss is covered; and fixed coverage, in which the losses up to the agreed amount, less deductible, are reimbursed. Floods were assumed to be log normally distributed. The effects of the insurance purchase of uncertainties in the distribution parameters were explored using response surface analysis. When maximum liability is known, the decision to purchase fixed coverage flood insurance is relatively insensitive to changes in the flood distribution. Fixed coverage insurance shifts the effects of hydrologic uncertainty to the insurer, but coinsurance puts a part of the uncertanty on the purchaser. If it is decided that flood plain residents should bear a greater part of the uncertainties, then coinsurance should be offered instead of fixed coverage insurance. Under fixed coverage, reductions in uncertainty have little influence on a customer's decision to purchase insurance. (Cassar-FRC)
W81-04930

## 6G. Ecologic Impact Of Water Development

**URBAN STORMWATER MANAGEMENT AND TECHNOLOGY: CASE HISTORIES,**
Metcalf and Eddy, Inc., Palo Alto, CA.
For primary bibliographic entry see Field 4A.
W81-04711

**LAKE LANSING RESTORATION--ITS GOALS, SUCCESSES AND DISAPPOINTMENTS,**
Ingham County Dept. of Public Works and Drain Commission, Lansing, MI.
For primary bibliographic entry see Field 2H.
W81-04733

**THE APPLICATION OF THE BIOCENOTIC MODEL FOR THE PREDICTION OF THE EFFECTS OF AN IMPOUNDMENT OF FLOWING WATER,**
Baden-Wurttemberg Landesanstalt fuer Umweltschutz (Germany, F.R.).
M. Boes.
Water Science and Technology, Vol 13, No 2, p Tor 1061-1072, 1981. 8 Fig, 11 Ref.

Descriptors: *Model studies, *Reservoirs, Murg River, Black Forest, Oxygen balance, Oxygen depletion, Sedimentation, Aeration, Ecological effects, Water quality, Diversion, Germany.

A biocenotic model was applied in efforts to determine what effect impounding the Murg River in the Black Forest would have on the water quality of that river. Impoundment would result from planned impoundment stages of the Rhine River. Various factors had to be considered, including the sedimentation of organic materials, the possible photosynthetic production of biomass or secondary pollution, the role of self purification performed by planktonic organisms, probable results from a reduction in physical aeration, and the changes in the composition of the wastewater and the residual biogradability with deterioration of the BODS/BOD total ratio brought about by the development of sewage treatment plants. The biocenotic model was constructed to compute the oxygen budget and the organic pollution for given loads. The results of the computations with this model suggest that impoundage of the Murg will lead to critical situations in the oxygen budget. Oxygen deficiencies and difficulties related thereto will occur only temporarily and locally. If it is deemed that this impoundage is necessary, then advanced wastewater treatment sections for the more important wastewater discharges must be planned or a few aeration stations be installed in the backwater zone. It is suggested that a diversion of the Murg into the tailwater of the weir be done. (Baker-FRC)
W81-04812

# 7. RESOURCES DATA

## 7A. Network Design

**RESULTS AND EVALUATION OF A PILOT PRIMARY MONITORING NETWORK, SAN FRANCISCO BAY, CALIFORNIA, 1978,**
Geological Survey, Menlo Park, CA. Water Resources Div.
W. L. Bradford, and R. T. Iwatsubo.
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-207466, Price codes: A06 in paper copy, A01 in microfiche. Geological Survey Water-Resources Investigations 80-73, October, 1980. 115 p, 9 Fig, 6 Tab, 21 Ref.

Descriptors: *Network design, *Monitoring, *Water quality, *Estuaries, Hydrodynamics, Data collections, Sampling, Water analysis, Calibrations, Water pollution control, *California, *San Francisco Bay.

A primary monitoring network of 12 stations, with measurements at 1-meter depth intervals every 2 weeks during periods of high inflow from the Sacramento-San Joaquin River delta, and every 4-6 weeks during seasonal low delta inflows, appears adequate to observe major changes in ambient water quality in San Francisco Bay. A 1-year study tested the network operation and determined that analysis of the data could demonstrate the major changes in salinity, temperature, and light-attenuation distributions known to occur, based on earlier research, in response to variations of delta inflow and to other physical processes. Observations of eddies at two stations, of the influence of water from a river flooding in the extreme south bay, and of difference in salinity and temperature laterally across the entrance to the south bay are all new but are consistent with existing models. The pH, dissolved oxygen, and light-attenuation measurements, while adequate to observe small-scale vertical variations, are not sufficiently sensitive to detect the effects of phytoplankton blooms. (USGS)
W81-04674

**THE USE OF THE MULTIDIMENSIONAL ANALYSIS IN THE COMPARISON OF THE 1976 VS 1971 RIVER SEINE BASIN SURVEYS,**
Ecole Centrale des Arts et Manufactures, Chatenay Malabry (France). Laboratories de Mathematiques Appliquees.
Y. Le Foll, and A. Lesouef.
Water Science and Technology, Vol 13, No 2, p Tor 1011-1033, 1981. 10 Fig, 3 Tab, 10 Ref.

Descriptors: *Mathematical analysis, *River basins, *Seine River, Mathematical studies, Monitoring, *Water quality, Water quality data, Basins, France, Comparison studies, Data collections.

A total of 110,000 measurements were taken in a monitoring program of the Seine River Basin between the years 1971 and 1976. This paper presents both the methodological aspects of the analysis and the classical methods used to interpret this mass of data. The methods of correspondence analysis provided an effective screening tool to rapidly draw attention toward the main phenomena when a fairly large number of data were involved, as was the case here. This method does not eliminate the need to look at detailed results and does not supersede the good traditional comparison of means, maps, river profiles and use of deterministic models. However, correspondence analysis does concentrate effort on aspects which are worthwile investigating. This is also an excellent method for calculating water quality indexes, and for making various classifications and discriminations essential for giving a rapid overall view of an existing situation or studying a large geographical area. (Baker-FRC)
W81-04811

## 7B. Data Acquisition

**TURBULENCE MEASUREMENT STUDY,**
Army Engineer District, New Orleans, LA.
O. F. Griffith, III, and C. Grimwood.
Journal of the Hydraulics Division, Proceedings of the American Socity of Civil Engineers, Vol 107, No HY3, p 311-326, March, 1981. 14 Fig, 7 Tab, 4 Ref.

Descriptors: *Turbulent flow, *Flow measurement, *Measuring instruments, Hydraulics, Flow, Electromagnetic waves, Fluid mechanics, Flow characteristics, Water metering, Water currents, Fourier analysis, Lake Ponchartrain.

Increasing concern regarding the environmental effects of changes in flow patterns for bodies of water and streams demands that flow parameters characterizing turbulence be measured and understood. The feasibility of using a modified commercially available electromagnetic current meter to measure parameters which would characterize turbulent flows from field measurements in rivers and lake inlets was evaluated. Values of turbulence intensity were measured, and Fourier analyses of their oscillograph recordings were performed to obtain the spectral distribution of the energy. Field tests were then conducted at three locations selected on the basis of their differences in flow regime. The results showed that values of turbulent intensity for flows between very high to light turbulence levels ranged from 0.71 to 0.06, respectively, and the Fourier analysis of the data shows the energy to be concentrated generally below 5 Hz. It is concluded that with this instrument a method has been developed to quantitatively compare turbulence intensity and to obtain spectral signatures of turbulent flows in the field. It is anticipated that these techniques will be used in the analysis of the flows in channels connecting Lake Ponchartrain in Louisiana and the Gulf of Mexico. (Carroll-FRC)
W81-04767

**COMPARISON OF TWO SURFACE HEAT EXCHANGE MODELS,**
Wyoming Univ., Laramie. Dept. of Chemical Engineering.
R. D. Noble.
Journal of the Hydraulics Division, Proceedings of the American Society of Civil Engineers, Vol 107, No HY3, p 361-366, March, 1981. 15 Ref.

Descriptors: *Mathematical models, *Mathematical equations, *Water temperature, *Heat transfer, Temperature, Physical properties, *Air-water interfaces, *Comparison studies.

Since the nonlinearity of some terms in the expression for the net heat flux at the air-water interface has made it impossible to develop analytic solutions for the water temperature in many cases, methods have been developed to linearize the net heat flux expression. The concept of the equilibrium temperature, defined as the temperature which the water surface would attain when the net heat flux became zero, was developed to linearize the net heat flux expression. The equilibrium temperature method has been applied to predictive models for water temperature. This paper demonstrates that a relationship can be developed which relates the parameters in the equilibrium temperature model to the parameters in the Taylor Series expansion model, allowing the use of either method by interchanging the parameters in the manner illustrated. The paper also shows that the equilibrium temperature model is a special case of the Taylor Series expansion model. (Carroll-FRC)
W81-04770

**LEAST-COST OPTIMIZATION FOR AREAWIDE (208 WASTEWATER MANAGEMENT USING MIXED INTEGER PROGRAMMING,**
Weston (Roy F.) Roslyn, NY.
For primary bibliographic entry see Field 5D.
W81-04810

**FACT AND ARTIFACT IN COPEPOD FEEDING EXPERIMENTS,**
Woods Hole Oceanographic Institution, MA.
G. R. Harbison, and V. L. McAlister.
Limnology and Oceanography Vol 25, No 6, p 971-981, November, 1980. 7 Fig, 4 Tab, 20 Ref.

Descriptors: *Copepods, *Food habits, *Phytoplankton, *Particle size, Eutrophication, Animal behavior, Algae, Rhizosolenia setigera, Fate of pollutants, Measuring instruments, Grazing, Errors.

Recent work concluding that copepods feeding on natural asemblages of algae show opportunistic or flexible feeding behavior does not prove this fact for several reasons. First, the sensing-zone counters size the particles according to their volume, not their linear dimensions, and second, sieves remove particles on the basis of their linear dimensions, not their volumes. Thus, if phytoplankton mixtures are passed through sieves and then sized with a sensing-zone counter, the inanimate sieve will exhibit feeding behavior. In addition, the breakage of algal particles during agitation and feeding is a source of error in interpretation. Experiments on algal volumes with a Coulter Counter showed general agreement with visual observations on spherical cells. However, volumes and Rhizosolenia setigera cells, ranging from 210-640 micrometers in length and 20-37 micrometers in diameter with spines, were greatly underestimated by the Coulter method. (Cassar-FRC)
W81-04816

**MICRO-EDOSION METER MODIFIED FOR USE UNDER WATER,**
Guelph Univ. (Ontario). Dept. of Geography.
R. W. Askin, and G. D. Davidson-Arnott.
Marine Geology, Vol 40, No 3/4, p M45-M48, 1981. 1 Fig, 4 Ref.

Descriptors: *Measuring instruments, *Erosion rates, Underwater, Lakes, Corrosion, Nearshore processes, Geologic formations, *Lake Ontario.

A microerosion meter was modified to measure erosion rates in underwater overconsolidated tills in Lake Ontario. The dial gage and base swivel were eliminated to minimize damage and corrosion during underwater use. The resulting reduction in precision is not a problem because the rates of vertical erosion in till are on the order of tens of mm per year. The apparatus consists of an aluminum triangular base plate, sides 22 cm long, with pins underneath to position it in the bed. A 15 cm probe has a flat 2 cm diameter circular base to prevent the rod from penetrating the till. After allowing the probe to drop to the bed and clamping it in place with a set screw, the depth can be read on a millimeter scale. (Cassar-FRC)
W81-04822

**THE APPLICATION OF Q-MODE FACTOR ANALYSIS TO SUSPENDED PARTICULATE MATTER STUDIES: EXAMPLES FROM THE NEW YORK BIGHT APEX,**
National Oceanic and Atmospheric Administration, Miami, FL. Atlantic Oceanographic and Meteorological Labs.
For primary bibliographic entry see Field 5B.
W81-04823

**MORE COMPLICATIONS IN THE CHLOROPHYLL-SECCHI DISK RELATIONSHIP,**
Kent State Univ., OH. Dept. of Biological Science.
For primary bibliographic entry see Field 2H.
W81-04825

**ENVIRONMENTAL APPLICATIONS OF MAGNETIC MEASUREMENTS,**
Edinburgh Univ. (Scotland). Dept. of Geophysics.
R. Thompson, J. Bloemendal, J. A. Dearing, F. Oldfield, and T. A. Rummery.
Science, Vol 207, No 4430, p 481-486, February 1, 1980. 8 Fig, 1 Tab, 27 Ref.

Descriptors: *Magnetic studies, *Sedimentology, *Erosion, Minerals, *Lake sediments, Dating, Sediment transport, Paleoclimatology, Sedimentation, Climatology.

Magnetic measurements have many advantages over conventional methods for use in environmental studies. In both the field and the laboratory, magnetic techniques are useful for reconnaissance work due to their speed and flexibility. The transformation, movement, and quantification of magnetic minerals between the atmosphere, lithosphere and hydrosphere may be investigated by magnetic measurements. The erosion of magnetic minerals into lakes may also be monitored by magnetic methods. The paleomagnetic dating of lake sediments has become a widely accepted and useful process. Stable remanence directions have been used to date sediments by matching the oscillations with a master geomagnetic secular variation curve. When the whole-core magnetic correlation and dating technique is extended to a grid spanning a whole lake, accurate measurements of total sedimentation may be made. Magnetic measurements may also provide insights into the nature of major climatic shifts of the Pleistocene in areas ranging from arctic-alpine to humid tropical. (Geiger-FRC)
W81-04827

**THE CANADIAN NORTH: UTILITY OF REMOTE SENSING FOR ENVIRONMENTAL MONITORING,**
Howard Univ., Washington, DC. Dept. of Geography.
B. Dey, and J. H. Richards.
Remote Sensing of Environment, Vol 11, No 1, p 57-72, March, 1981. 8 Fig, 31 Ref.

Descriptors: *Potential water supply, *Remote sensing, *Satellite technology, Sensors, Data acquisition, Hydrologic data collections, Water resources development, Weather forecasting.

Remote sensing offers the chance to view large or inaccessible areas of the earth and secure data to answer various environmental questions. Remote sensing uses measurements of ultraviolet, visible, infrared, and microwave radiations emitted by, reflected from, and absorbed by both the earth's surface and atmosphere to form its data base. Most environmental monitoring in the recent past had been done by the NOAA-5 satellite, but this is now being replaced by the TIROS-N and NOAA-6. Data gained can be used for weather prediction, monitoring of water quality, monitoring of snow cover, monitoring of ice cover, monitoring erosion and depositional features, and sensing of biotic phenomena. The use of remote sensing for the monitoring of water quality is still in the research or semioperational stage. Its techniques can best be used to monitor phenomena such as sedimentation. In Canada, NOAA-VHRR (very high resolution radiometry) imagery has been used as basic input in snowmelt runoff forecast models, while its gray scale has been used successfully to measure snow depth up to 10 cm. Possibly the most advanced techniques in the general area of mapping erosional and depositional features are those applicable to the monitoring and predicting of river flooding. However, the timing and timeliness of data acquisition still present a problem in this area. (Baker-FRC)
W81-04830

**HCMM DETECTION OF HIGH SOIL MOISTURE AREAS,**
Texas A and M Univ., College Station. Remote Sensing Center.
J. L. Heilman, and D. G. Moore.
Remote Sensing of Environment, Vol 11, No 1, p 73-76, March, 1981. 4 Fig, 3 Ref.

Descriptors: *Remote sensing, *Soil moisture, *Satellite technology, Sensors, Data acquisition, Hydrologic data collections, Water resources, Soil moisture retention, Thermal radiation.

One objective of the Heat Capacity Mapping Mission (HCMM) of NASA is to evaluate the feasibility of using HCMM data to assess soil moisture effects by observing temperatures near the maximum and minimum of the diurnal temperature cycle. In early April 1978, heavy runoff from snowmelt and ice blockage caused significant flooding of alluvial areas in a portion of the Big Sioux River Basin in southeastern South Dakota. Flood waters receded by mid-May, but an area of high soil moisture content remained. Soil moisture in the surrounding terrace soils was generally less than in the flood plain. This area appeared warmer than surrounding areas on May 14 HCMM night thermal imagery and cooler than surrounding areas on May 15 HCMM day thermal imagery. These differences were probably the result of thermal inertia and evaporation differences associated with soil moisture differences. The superiority of the HCMM thermal data acquired over Landsat data for assessing soil-moisture differences was demonstrated in this area. (Baker-FRC)
W81-04831

**THERMAL INFRARED DATA FROM THE HEAT CAPACITY MAPPING MISSION,**
National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center.
Remote Sensing of Environment, Vol 11, No 1, p 77-79, March, 1981, 1 Fig.

Descriptors: *Remote sensing, *Satellite technology, Sensors, Data acquisition, Hydrologic data collections, Water resources development, *Potential water supply.

The Heat Capacity Mapping Mission (HCMM) is part of the space program whereby remote sensing operations can be used for terrestrial applications. The thermal infrared data obtained from the HCMM revealed the surface of the earth as it reflected solar radiation and emitted thermal radiation in the visible and infrared channels, respectively. The satellite is able to observe midlatitude regions over the course of the diurnal heating cycle. The HCMM thermal infrared measurements can be used to examine the amplitude of day/night variations in surface temperature on a regional basis. They can also estimate the apparent thermal inertia of surficial cover materials. A nighttime thermal infrared HCMM image of Utah reveals the Great Salt Lake with a color variation caused by salinity and circulation differences affecting the lake's thermal properties. Lake Powell is also clearly visible as a bright area on the image, while clouds appear as dark areas. Processing and reduction of HCMM data are still in progress. (Baker-FRC)
W81-04833

**DURATION OF GRAIN FILLING AND KERNEL WEIGHT OF WHEAT AS AFFECTED BY TEMPERATURE,**
Science and Education Administration, Weslaco, TX. Soil and Water Conservation Research.
C. L. Wiegand, and J. A. Cuellar.
Crop Science, Vol 21, No 1, p 95-101, January/February, 1981. 4 Fig, 2 Tab, 41 Ref.

Descriptors: *Crops, Temperature, Agriculture, Crop yield, Water stress, Moisture, *Temperature effects, Thermal stress, *Wheat, Plant physiology.

In this paper grain filling duration and kernel weight data obtained in connection with phenological and yield components observations were related to one environmental variable, mean daily air temperature during grain filling. The purpose was to determine how strongly temperature affects the kernel weight component of wheat grain yields. The data indicated a 3.1 day shortening of grain filling per degree C increase in mean daily air temperature during grain filling, which compares with 2.8 days/C degree for seven studies reported in the literature. The findings suggest that genetic variability in plant senescence and grain filling rates should be examined and exploited to help stabilize the kernel size component of the yield. (Baker-FRC)
W81-04872

**METHODS FOR WATER SUPPLY FORECASTING,**
GKY and Associates, Inc., Alexandria, VA.
G. K. Young, T. R. Bondelid, and S. A. Daley.

Water Resources Research, Vol 16, No 3, p 556-564, June, 1980. 4 Fig, 5 Ref.

Descriptors: *Water supply, *Forecasting, Weather forecasting, Potential water supply, Predictions, Projections, Rainfall-runoff relationships, Rainfall.

A case study approach to analysis is presented which uses a cost effective method for generating extended streamflow predictions (ESP). The use of this method provides probabilistic streamflows during designated time periods. The basis for the method is the data from rainfall, which permits a sensitivity analysis of rainfall inputs and resulting streamflow of calibrated rainfall/runoff models. Knowledge of the variances and sensitivities of R/R model input parameters is assumed, allowing the variance of the output to be determined. Monthly rainfall is assumed to be Markovian. This assumption is used to select input rainfall data. The case study reported is for the Occoquan watershed in northern Virginia. The period of time covered a phase of severe drought. Streamflow variance calculated was within 12% of the value obtained by the current National Weather Service technique. Less than 10% of the computer effort required by the National Weather Service method was needed when using the ESP method. (Baker-FRC)
W81-04911

**A CLEAR-SKY SPECTRAL SOLAR RADIATION MODEL FOR SNOW-COVERED MOUNTAINOUS TERRAIN,**
California Univ., Santa Barbara. Dept. of Geography.
J. Dozier.
Water Resources Research, Vol 16, No 4, p 709-718, August, 1980. 6 Fig, 2 Tab, 52 Ref.

Descriptors: *Solar radiaton, *Hydrologic models, *Snowmelt, Satellite technology, Mountains, Model studies, Mathematical models.

Incident or net spectral solar radiation under clear skies may be calculated over a mountainous snow-covered area from a few, easily obtainable measurements. The results can be used with snowmelt runoff models or can be compared with satellite space radiance measurements. Values for atmospheric turbidity and water vapor are calculated from global solar radiation with instrument easy to operate in the field or in unattended installations. Independent variables are grouped into four classes: radiative, astronomic/temporal, topographic/geographic and atmospheric/geometric. For calculations over a specified area, the model uses tables, so that computation speed for the spectral model approaches that for a lumped model. (Cassar-FRC)
W81-04926

**CORRELATIONS BETWEEN BROOK TROUT GROWTH AND ENVIRONMENTAL VARIABLES FOR MOUNTAIN LAKES IN ALBERTA,**
Canadian Wildlife Service, Edmonton (Alberta).
D. B. Donald, R. S. Anderson, and D. W. Mayhood.
Transactions of the American Fisheries Society, Vol 109, No 6, p 603-610, November, 1980. 1 Fig, 4 Tab, 26 Ref.

Descriptors: *Trout, *Mountain lakes, *Groth, Fishing, Fish, Lakes, *Alberta, Canada, Benthic environment, Amphipods, Crustaceans, Water analysis, Water temperature, Turbidity, Chemical analysis, Evaluation.

Factors which affect brook trout growth are identified, and some preliminary models are used to predict the size brook trout will reach if they are introduced into mountain lakes not having this species. Brook trout populations were studied in 23 lakes in Banff, Jasper, and Waterton Lakes national parks. The weight reached by age-5 brook trout ranged from a low of 65g in Temple Lake to a high of 1,751g in Patricia Lake. Growth curves were usually sigmoid. The mean weight of age-5 fish in all populations studied was 520g. The oldest fish caught was at least 18 yr old and could have been older. The largest brook trout caught was an age 6+ female of 2,675g in Caledonia Lake. There was a positive relationship between amphipod abundance in the lakes, the relative importance of this food item in the diet of brook trout, and the groth of brook trout. Amphipods were largely benthic in lakes that had fish populations, although amphipods can be planktonic in other lakes. (Baker-FRC)
W81-04980

## 7C. Evaluation, Processing and Publication

**HYDROGEOLOGIC DATA FROM THE NORTHERN PART OF THE TOWN OF BROOKHAVEN, SUFFOLK COUNTY, NEW YORK,**
Geological Survey, Syosset, NY. Water Resources Div.
E. J. Koszalka.
Suffolk County Water Authority. Long Island Water Resources Bulletin 15, 1980. 80 p, 2 Fig, 3 Plates, 9 Tab, 15 Ref.

Descriptors: *Surface water, *Groundwater, *Water quality, *Data collections, Geohydrology, Water level, Observation wells, Aquifers, Water table, Water supply, Water analysis, Chemical analysis, *New York, Suffolk County, *Town of Brookhaven.

Water levels in observation wells in the northern part of the Town of Brookhaven, N.Y., indicate that the water table currently has a maximum altitude of 75 feet above National Geodetic Vertical Datum and the potentiometric surface of the Magothy aquifer has a maximum altitude of 65 feet. Water-quality analyses of ground water and surface water indicate that, with a few exceptions, water is acceptable for drinking and most uses. Total withdrawal for public supply in 1977 was about 23.11 million gallons per day. The upper glacial aquifer contributed 15.04 million gallons per day, and the Magothy aquifer 8.07 million gallons per day. Withdrawals by private firms accounted for less than 5 percent of the total. The hydrogeology of the northern part of the Town of Brookhaven is briefly described. A well-location map, a water-table map, and a potentiometric-surface map of the Magothy aquifer are included; water-quality analyses of water from 88 wells and 7 selected streams are presented in tables. (USGS)
W81-04663

**GROUND-WATER LEVELS IN SELECTED WELL FIELDS AND IN WEST-CENTRAL FLORIDA, SEPTEMBER 1979,**
Geological Survey, Tampa, FL. Water Resources Div.
D. K. Yobbi, L. R. Mills, and W. M. Woodham.
Available from OFSS, USGS Box 25425, Fed. Ctr., Denver, CO 80225 Price: paper copy $7.00, microfiche $1.00. Geological Survey Open-File Report 80-210, 1979. 2 Sheets, 2 Tab, 8 Ref.

Descriptors: *Potentiometric level, *Groundwater, *Maps, Subsurface water, Aquifers, Water table, Wells, Water level fluctuations, *West-central Florida, Floridan aquifer.

The water table in the surficial aquifer and the potentiometric surface of the Floridan aquifer in a 1,200-square-mile area in west-central Florida are mapped semiannually by the U.S. Geological Survey. Maps are based on water levels measured in wells each May to coincide with seasonal low levels, and each September to coincide with seasonal high levels. The mapped area shows 16 well fields which supplied 123.7 million gallons to municipalities on September 18, 1979. The water is withdrawn from the Floridan aquifer, the major aquifer in Florida. The effect of localized withdrawal of ground water is shown on the maps as depressions in both the potentiometric and water-table surfaces. Water levels were generally higher in September 1979 than in May 1979 and higher than the average September levels. Change of water levels ranged from an increase of 15 feet at Cosme well field to a decrease of 9 feet at Verna well field. (USGS)
W81-04666

**POTENTIOMETRIC SURFACE OF THE FLORIDAN AQUIFER, SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT, SEPTEMBER 1979,**
Geological Survey, Tampa, FL. Water Resources Div.
D. K. Yobbi, W. M. Woodham, and C. P. Laughlin.
Available from OFSS, USGS Box 25425, Fed. Ctr., Denver, CO 80225 Price: paper copy $1.75, microfiche $0.50. Geological Survey Open-File Report 80-46, 1980. 1 Sheet.

Descriptors: *Potentiometric level, *Groundwater, *Maps, Aquifers, Water table, Wells, Water level fluctuations, Pumping, Irrigation, *Southwest Florida, Southwest Florida Water Management, Florida.

A September 1979 potentiometric-surface map of the Southwest Florida Water Management District depicts the annual high water-level period. Potentiometric levels increased 1 to 20 feet between May 1979 and September 1979, in the citrus and farming sections of southern Hillsborough, northern Hardee, southwestern Polk, northwestern DeSoto, and Manatee Counties. Water levels in these areas are widely affected by pumping for irrigation and have the greatest range in fluctuations. Water-level increases ranged from 0 to 7 feet in coastal, northern, and southern areas of the Water Management District. Generally, potentiometric levels were higher than previous September levels due to heavy rains in August and September. (USGS)
W81-04667

**WATER TABLE IN THE SURFICIAL AQUIFER AND POTENTIOMETRIC SURFACE OF THE FLORIDAN AQUIFER IN SELECTED WELL FIELDS, WEST-CENTRAL FLORIDA, MAY 1979,**
Geological Survey, Tampa, FL. Water Resources Div.
R. M. Wolansky, D. K. Yobbi, L. R. Mills, and W. M. Woodham.
Available from OFSS, USGS Box 25425, Fed. Ctr., Denver, CO 80225 Price: paper copy $7.00, microfiche $1.00. Geological Survey Open-File Report 79-1350, 1979. 2 Sheets, 2 Tab, 7 Ref.

Descriptors: *Potentiometric level, *Groundwater, *Maps, Subsurface water, Aquifers, Water table, Wells, Water level fluctuations, *West-central Florida, *Floridan aquifer, Florida.

The water table is the surficial aquifer and the potentiometric surface of the Floridan aquifer in a 1,200-square-mile area in west-central Florida are mapped semiannually by the U.S. Geological Survey. Maps are prepared showing water levels measured in wells each May to coincide with seasonal low levels, and each September to coincide with seasonal high levels. The mapped area shows 16 well fields which supplied 128 million gallons to municipalities on May 15, 1979. The water is withdrawn from the Floridan aquifer, the major aquifer in Florida. Water levels were significantly higher in May 1979 than in May 1978. Heavy rains on May 7 and 8th deluged the well-field areas with 2 to 18 inches of rain. The maximum increase in water levels from May 1978 to May 1979 was more than 8 feet at the Eldridge-Wilde well field. (USGS)
W81-04668

**DATA ON SELECTED LAKES IN WASHINGTON, PART 6,**
Geological Survey, Tacoma, WA. Water Resources Div.
N. P. Dion, G. C. Bortleson, and J. K. Innes.
Washington State Department of Ecology Water-Supply Bulletin 42, Part 6, 1980. 125 p, 1 Fig, 33 Ref.

Descriptors: *Lakes, *Data collections, *Water quality, *Lake morphometry, Baseline studies, Chemical properties, Physical properties, Biological properties, Bathymetry, Maps, Aerial photography, Water temperature, *Washington.

This report, the sixth in a series, contains physical, chemical, and biological data collected from 24

lakes in eastern and western Washington during 1975. For each lake is given a description of the physical setting, a general discussion of water quality, a bathymetric map, and an aerial photograph. The basic data include depth profiles of dissolved-oxygen concentration and temperature. In general, the study consists of a data-collection program designed to (1) document the present water quality and the overall status of the lakes, and (2) provide basic data pertaining to the physical, cultural, and water-quality characteristics of lakes in order to establish a base of reference that will allow periodic appraisals of future lake conditions. (USGS)
W81-04673

**WATER RESOURCES DATA FOR KENTUCKY, WATER YEAR 1980.**
Geological Survey, Louisville, KY. Water Resources Div.
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-223612, Price codes: A99 in paper copy, A01 in microfiche. Geological Survey Water-Data Report KY-80-1, 1981. 804 p, 7 Fig, 4 Tab, 23 Ref.

Descriptors: *Hydrologic data, *Surface water, *Groundwater, *Water quality, Gaging stations, Streamflow, Flow rates, Sediment transport, Water analysis, Water temperature, Chemical analysis, Lakes, Reservoirs, Wells, Water level, Data collections, Sites, *Kentucky.

Water resources data for the 1980 water year for Kentucky consist of records of stage, discharge, and water quality of streams; stage and contents of lakes; and water levels and water quality of wells and springs. This report contains discharge records from 116 gaging stations; stage and contents for 15 lakes; suspended-sediment data for 43 stations (28 daily); daily temperature records for 35 stations; daily specific conductance for 24 stations; groundwater levels for 74 recording and 85 partial; water-quality data from 232 coal hydrology sites (28 partial, 204 miscellaneous), 3 springs, and 311 wells; and miscellaneous temperature and specific conductance data from the 116 gaging stations. Also included are data for 123 partial-record crest-stage and 102 partial-record low-flow sites. Data collected at various miscellaneous sites are also published. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Kentucky. (USGS)
W81-04675

**WATER RESOURCES DATA FOR NEW YORK, WATER YEAR 1980--VOLUME 1. EASTERN NEW YORK EXCLUDING LONG ISLAND.**
Geological Survey, Albany, NY. Water Resources Div.
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-227308, Price codes: A14 in paper copy, A01 in microfiche. Geological Survey Water-Data Report NY-80-1, 1981. 310 p, 5 Fig, 1 Tab.

Descriptors: *Hydrologic data, *Surface water, *Groundwater, *Water quality, Gaging stations, Streamflow, Flow rates, Sediment transport, Water analysis, Water temperature, Chemical analysis, Lakes, Reservoirs, Wells, Water level, Data collections, Sites, *New York, Eastern New York.

Water resources data for the 1980 water year for New York consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels of groundwater wells. This volume contains records for water discharge at 105 gaging stations, stage only at 10 gaging stations, stage and contents at 20 gaging stations and 18 other lakes and reservoirs, water quality at 33 gaging stations, and water levels at 25 observation wells. Also included are data for 63 crest-stage and 27 low-flow partial-record stations. Additional water data were collected at various sites not involved in the systematic data-collection program and are published as miscellaneous measurements and analyses. These data together with the data in Volumes 2 and 3 represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State, local, and Federal agencies in New York. (USGS)
W81-04676

**WATER RESOURCES DATA FOR OHIO, WATER YEAR 1980--VOLUME 2. ST. LAWRENCE RIVER BASIN.**
Geological Survey, Columbus, OH. Water Resources Div.
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-217077, A12 in paper copy, A01 in microfiche. Geological Survey Water-Data Report OH-80-2, 1981. 257 p, 2 Fig.

Descriptors: *Hydrologic data, *Surface water, *Groundwater, *Water quality, Gaging stations, Streamflow, Flow rates, Sediment transport, Water analysis, Water temperature, Chemical analysis, Lakes, Reservoirs, Wells, Water level, Data collections, Sites, *Ohio, *St. Lawrence River basin.

Water resources data for the 1980 water year for Ohio consist of records of stage, discharge, and water quality of streams; stage and contents, and water quality of lakes and reservoirs; and water levels and water quality of groundwater wells. This report in two volumes and one appendix contains records for water discharge at 169 gaging stations, stage and contents at 39 lakes and reservoirs, water quality at 57 gaging stations and 83 wells, and water levels at 183 observation wells. Also included are data from 84 crest-stage partial-record stations; 9 low-flow partial-record stations, and 537 coal hydrology synoptic sites. Additional water data were collected at various sites not involved in the systematic data-collection program and are published as miscellaneous measurements and analyses. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies in Ohio. (USGS)
W81-04677

**WATER RESOURCES DATA FOR SOUTH DAKOTA, WATER YEAR 1980.**
Geological Survey, Huron, SD. Water Resources Div.
Available from the National Technical Information Service, Springfield, VA 22161 as PB82-101338, Price codes: A20 in paper copy, A01 in microfiche. Geological Survey Water-Data Report SD-80-1, 1981. 454 p, 6 Fig.

Descriptors: *Hydrologic data, *Surface water, *Groundwater, *Water quality, Gaging stations, Streamflow, Flow rates, Sediment transport, Water analysis, Water temperature, Chemical analysis, Lakes, Reservoirs, Wells, Water level, Data collections, Sites, *South Dakota.

Water resources data for the 1980 water year for South Dakota consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels in wells. This report contains discharge records for 112 gaging stations, stage and contents for 10 lakes and reservoirs, water quality for 22 gaging stations, and water levels for 6 observation wells. Also included are 37 crest-stage partial-record stations. Additional water data were collected at various sites, not part of the systematic data-collection program, and are published as miscellaneous measurements and analyses. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in South Dakota. (USGS)
W81-04678

**WATER RESOURCES DATA FOR IOWA, WATER YEAR 1980.**
Geological Survey, Iowa city, IA. Water Resources Div.
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-213399, Price codes: A13 in paper copy, A01 in microfiche. Geological Survey Water-Data Report IA-80-1, 1981. 276 p, 10 Fig.

Descriptors: *Hydrologic data, *Surface water, *Groundwater, *Water quality, Gaging stations, Streamflow, Flow rates, Sediment transport, Water analysis, Water temperature, Chemical analysis, Lakes, Reservoirs, Wells, Water level, Data collections, Sites, *Iowa.

Water resources data for the 1980 water year for Iowa consists of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels in wells. This report contains discharge records for 117 gaging stations, stage and contents for 7 lakes and reservoirs, water quality for 25 gaging stations, and water levels for 34 observation wells. Also included are 126 crest-stage partial-record stations. Additional water data were collected at various sites, not part of the systematic data-collection program, and are published as miscellaneous measurements and analyses. The data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Iowa. (USGS)
W81-04679

**WATER RESOURCES DATA FOR NORTH CAROLINA, WATER YEAR 1980.**
Geological Survey, Raleigh, NC. Water Resources Div.
Geological Survey Water-Data Report NC-80-1, 1981. 459 p, 3 Fig.

Descriptors: *Hydrologic data, *Surface water, *Groundwater, *Water quality, Gaging stations, Streamflow, Flow rates, Sediment transport, Water analysis, Water temperature, Chemical analysis, Lakes, Reservoirs, Wells, Water level, Data collections, Sites, *North Carolina.

Water resources data for the 1980 water year for North Carolina consist of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; and ground-water levels. This report contains discharge records for 156 gaging stations, stage and contents for 24 lakes and reservoirs, water quality for 57 gaging stations and 7 miscellaneous sites, and water levels for 64 observation wells. Additional water data were collected at various sites, not involved in the systematic data-collection program, and are published as miscellaneous measurements in this report. The collection of water-resources data in North Carolina is a part of the National Water-Data System operated by the U.S. Geological Survey in cooperation with State, municipal, and Federal agencies. (USGS)
W81-04680

**WATER RESOURCES DATA FOR OKLAHOMA, WATER YEAR 1979--VOLUME 1. ARKANSAS RIVER BASIN.**
Geological Survey, Oklahoma City, OK. Water Resources Div.
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-212748, Price codes: A99 in paper copy, A01 in microfiche. Geological Survey, Oklahoma City, OK. Water Resources Div.

Descriptors: *Hydrologic data, *Surface water, *Groundwater, *Water quality, Gaging stations, Streamflow, Flow rates, Sediment transport, Water analysis, Water temperature, Chemical analysis, Lakes, Reservoirs, Wells, Water level, Data collections, Sites, *Oklahoma, *Arkansas River basin.

Water resources data for the 1979 water year for Oklahoma consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes or reservoirs. Volumes 1 and 2 of this report contain discharge records for 132 gaging stations, stage and contents for 26 lakes or reservoirs, water quality for 133 gaging stations and 3 lakes, and water levels for 48 wells. Also included are 43 crest-stage partial-record stations. Additional water data were collected at various sites, not part of the systematic data-collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S.

Geological Survey and cooperating State and Federal agencies in Oklahoma. (USGS)
W81-04681

**WATER RESOURCES DATA FOR OKLAHOMA, WATER YEAR 1979--VOLUME 2.**
Geological Survey, Oklahoma City, OK. Water Resources Div.
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-213431, A12 in paper copy, A01 in microfiche. Geological Survey Water-Data Report OK-79-2, 1981. 249 p, 8 Fig.

Descriptors: *Hydrologic data, *Surface water, *Groundwater, *Water quality, Gaging stations, Streamflow, Flow rates, Sediment transport, Water analysis, Water temperature, Chemical analysis, Lakes, Reservoirs, Wells, Water level, Data collections, Sites, *Oklahoma, *Red River basin.

Water resources data for the 1979 water year for Oklahoma consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes or reservoirs. Volumes 1 and 2 of this report contain discharge records for 132 gaging stations, stage and contents for 26 lakes or reservoirs, water quality for 133 gaging stations and 3 lakes, and water levels for 48 wells. Also included are 43 crest-stage partial-record stations. Additional water data were collected at various sites, not part of the systematic data collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Oklahoma. (USGS)
W81-04682

**THE USE OF THE MULTIDIMENSIONAL ANALYSIS IN THE COMPARISON OF THE 1976 VS 1971 RIVER SEINE BASIN SURVEYS,**
Ecole Centrale des Arts et Manufactures, Chatenay Malabry (France). Laboratories de Mathematiques Appliquees.
For primary bibliographic entry see Field 7A.
W81-04811

**LIGHT, SECCHI DISKS, AND TROPHIC STATES,**
Minnesota Univ., Minneapolis. Dept. of Ecology and Behavioral Biology.
R. O. Megard, J. C. Settles, H. A. Boyer, and W. S. Combs, Jr.
Limnology and Oceanography, Vol 25, No 2, p 373-377, March, 1980. 3 Fig, 1 Tab, 8 Ref.

Descriptors: *Secchi disks, *Light penetration, *Lakes, *Chlorophyll, *Trophic level, *Phytoplankton, Algae, Limnology, Extinction coefficient, Water quality, Physical properties, Calibrations.

Lorenzen's (1980) criticism of Secchi disk-chlorophyll relationships which neglect non-chlorophyll light attenuating substances is substantiated with data from several lakes. Curves were developed for three lakes using both the Carlson (1977) traditional formula and the Lorenzen (1980) modification. The curves show that the extinction coefficient may be neglected for simplification purposes if concentrations of chlorophyll exceed 20-30 mb per cu meter. In highly colored lakes, ignoring the extinction coefficient will assign a much higher trophic level than algal biomass would indicate. The Secchi disk optical system should be calibrated for each lake and observer to obtain the most accurate data for formulating management policies for lakes and watersheds. (Cassar-FRC)
W81-04945

# 8. ENGINEERING WORKS

## 8A. Structures

**METHODOLOGY FOR OPTIMIZATION OF AN IRRIGATION SYSTEM WITH STORAGE RESERVOIRS,**
Idaho Univ., Moscow. Dept. of Agricultural Engineering.
M. J. Khanjani.
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-238586, Price codes: A15 in paper copy, A01 in microfiche. PhD Dissertation, August, 1980. 313 p, 36 Fig, 25 Tab, 216 Ref, 6 Append. OWRT-B-041-IDA(2).

Descriptors: *Snake River Valley Irrigation District, *Irrigation canals, *Reservoir design, Optimization, Reservoir capacity, Reservoir storage, Probability process, *Mathematical studies, *Model studies, Stochastic process, Linear programming, Cost-benefit analysis, Flood control, Hydropower, Evapotranspiration, Runoff, Percolation, Peak demand.

The study's objective was to utilize probability analysis and mathematical programming in planning the design and operation of an irrigation network with a chain of internal water storage reservoirs. Specific objectives were to (1) determine the best irrigation intervals and field water requirements during peak water consumption by a stochastical analysis of potential evapotranspiration, and to complete a cost-benefit analysis of the irrigation application subsystem; (2) specify locations and sizes of internal water storage reservoirs and compute design capacity of each segment of the irrigations distribution subsystem for the optimal least cost system. An area of approximately 1,865 ha in the Snake River Valley Irrigation District was selected for application of the proposed model. The following conclusions were drawn: (1) evapotranspiration follows a probability distribution important in determining design capacity of system components; (2) time of occurrence of evapotranspiration may follow a type of probability distribution; (3) least cost combinations of alternative farm service reservoir types and their sites and structures can be determined using mixed integer programming; (4) linear programming can be used for sensitivity and parametric analyses of the model; and (5) any types of constraints can be entered into the mixed integer or linear programming models. (de Coquereaumont-IPA)
W81-04653

**SUB-SURFACE IRRIGATION CHANNEL,**
E. J. Taylor-Smith.
U.S. Patent No 4,221,505, 15 p, 12 Fig, 10 Ref; Official Gazette of the United States Patent Office, Vol 998, No 2, p 563, September 9, 1980.

Descriptors: *Patents, *Subsurface irrigation, *Equipment, Channeling, Excavation, Trenches, Soil properties, Capillary action, *Irrigation engineering, *Irrigation design.

The apparatus of the invention digs a trench to a predetermined level relative to a plane such as a laser beam plane above the ground. A system of water channels is pressed into the bottom of the trench, and the materials that have been dug out to form the trench are returned. The channel system may be formed directly in the bottom of the trench, but it is preferable to screen the material dug from the trench, and to lay fine material on the bottom after which the channel system is pressed into this layer. The coarse materials are directed over the channels and the trench bottom. The returned material is coarse enough so that when water is directed into the channel system it will flow throughout this system and be available through capillary action for plants growing at the surface. A vehicle in accordance with this invention comprises a main frame to be moved over the ground, a digger unit mounted on the frame and operable to remove earth from the ground to form a trench of predetermined width and depth, and distributing means on the frame behind for spreading earth removed by the digger unit back over the trench bottom. (Sinha-OEIS)
W81-04745

**MICROGRAVITY SURVEYS FOR EVALUATION OF ELEVATION CHANGES DUE TO RESERVOIR IMPOUNDMENT,**
Army Engineer Waterways Experiment Station, Vicksburg, MS. Earthquake Engineering and Geophysics Div.
D. K. Butler.
Journal of the Geotechnical Engineering Division, Proceedings of the American Society of Civil Engineers, Vol 107, No GT3, p 355-361, March, 1981. 1 Fig, 1 Tab, 16 Ref.

Descriptors: *Microgravity surveys, *Reservoirs, *Elevation, Reservoir stages, *Postimpoundment, Gravity studies, Measurement techniques, Geophysics, Engineering geology, Groundwater level.

One of the primary observable effects of the impoundment of large reservoirs is the downward deflection of the earth's surface, presumably due to the imposed load. Reservoir filling and seasonal changes in reservoir level result in elevation changes and in changes in groundwater levels in permeable formations in the vicinity of the reservoir. This technical note assesses the potential of microgravity surveys for the evaluation of elevation changes due to reservoir impoundment, the size of reservoir which is likely to produce elevation changes large enough for detection by microgravity surveys, and the role of coupled microgravity and surface leveling or groundwater level monitoring surveys in areas with permeable bedrock. While microgravity surveys suffer from stringent demands and time-dependent interfering effects, repeated surveys show promise of being a valuable tool for studying elevation changes, or mass change effects associated with reservoir impoundment, or both. A reservoir representing a total postimpoundment load on the order of 1.1 million tons or greater is a candidate for microgravimetric studies for determining elevation changes. Microgravity studies survey nets are currently in operation at Libby Dam and Reservoir in Montana and at the Palmdale uplift area in California. (Carroll-FRC)
W81-04775

**VIBRATION TESTS OF FULL-SCALE EARTH DAM,**
Princeton Univ., NJ. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8D.
W81-04776

**COMPARATIVE STUDY OF DYNAMIC RESPONSE OF EARTH DAM,**
Princeton Univ., NJ. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8D.
W81-04778

**SAFETY OF A CONSTRUCTED FACILITY: GEOTECHNICAL ASPECTS,**
Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8D.
W81-04781

**FORWARD STORAGE,**
Instituto Tecnologico Regional de Tijuana, San Ysidro, CA. Centro Regional de Estudios Graduados e Investigacion Tecnologica.
For primary bibliographic entry see Field 6B.
W81-04783

**CONSTRUCTION OF LARGE CANAL ON COLLAPSING SOILS,**
Water and Power Resources Service, Denver, CO. Div. of Research.
P. C. Knodel.
Journal of the Geotechnical Engineering Division, Proceedings of the American Society of Civil Engineers, Vol 107, No GT1, p 79-94, January, 1981. 12 Fig, 7 Ref.

Descriptors: *Canal construction, *Subsidence, *Soil compaction, Canals, Soil engineering, Ponding, Cohesionless soils, Soil tests, San Luis canal, California.

Soil subsidence by compaction due to wetting is analyzed, and the construction of the San Luis Canal is discussed. The canal is 107 miles long and

has a capacity ranging from 13,100 cu ft/sec at the headworks to 7750 cu ft/sec at the lower end. Subsidence studies were carried out in the San Joaquin Valley, and the soil along the route of the canal was tested for looseness. Also, several field test ponds were installed to correlate probable shallow subsidence with the varying degrees of seriousness shown by the exploration program and laboratory tests. For construction in the collapsible soil areas, ponding was first performed, followed by drainage. Then, to provide a firmer subbase to support the concrete lining, specifications called for rolling the bottom of the canal and embankment foundations with eight passes of a 50-ton pneumatic-tired roller. Preponding was found to be successful. The canal was built during 1963-68 and has performed well to date. (Small-FRC)
W81-04800

**DESIGN NOMOGRAPHS FOR SLOTTED DRAIN HYDRAULICS,**
G. E. Morris.
Public Works, Vol 112, No 4, p 55-57, April, 1981. 3 Fig, 1 Ref.

Descriptors: *Drains, *Urban runoff, Storm runoff, Rainfall-runoff relationships, Storm drainage, Storm drains, Storm wastewater, Highways, Hydraulics, *Design criteria, Engineering.

The hydraulic characteristics of the slotted drain become increasingly important as they are used in more and more complex situations. Slotted drains consist of a corrugated steel pipe cut along the longitudinal axis and reinforced with a grate of solid spacer bars. They are installed flush with the surface; water drops through the opening and into the pipe and connected outlet. This drainage system replaces the commonly used system of berms and catch basins to intercept runoff from highways. A great deal of federal research and research at the state level in various locations was carried out to improve the original designs and adapt this solution to more extensive problems. Today, slotted drains can be used to intercept runoff in a typical curb-and-gutter as a slot-on-grade, or at a sag or low point to accommodate runoff carried by the gutter, or to capture carry-over from preceding drains. The drain can be installed in wide, flat areas to intercept overland sheet flow. (Baker-FRC)
W81-04815

**PRESSURE DROP IN AND OPERATION OF ICE-LINED SLURRY PIPELINES,**
V. N. Kondakov, Yu. K. Vitoshkin, and V. I. Goshtovt.
Fluid Mechanics-Soviet Research, Vol 9, No 4, p 13-18, July-August, 1980. 3 fig, 10 Ref.

Descriptors: *Pressure head, *Pumping tests, *Pipelines, *Slurries, Ice formation, Freezing, Arctic regions, Cold regions.

In Arctic regions slurry pipelines may have internal ice linings instead of exterior thermal insulation. Curves were developed for hydraulic gradient as a function of flow rate in ice-lined pipes for water at mean velocities of 0.6 to 2.1 meters per sec and for iron ore waste slurry velocities from 1.25 to 2 meters per sec. Slurry solids concentrations ranged from 3 to 6% by volume. Pressure drop was calculated for water and slurries as functions of different ice annulus thicknesses. Head delivery curves were presented for a centrifugal pump operating with water and slurry, ice-free pipelines conveying water and slurry, and ice-lined pipes carrying water and slurry. These graphs can show the critical velocity and outdoor temperature below which progressive freezing of pipeline contents will occur. (Cassar-FRC)
W81-04894

**VICTORIA'S SUGARLOAF PROJECT.**
International Water Power and Dam Construction, Vol 33, No 3, p 21-24, March, 1981. 4 Fig.

Descriptors: *Reservoirs, *Dams, *Water supply development, Sugarloaf Project, Water treatment facilities, Pumping plants, Water storage, Yarra River, *Australia.

The Sugarloaf Project will provide Melbourne, Australia, with 95,000 million liters of water storage by 1984. The scheme consists of the Yering Gorge intake and pumping station on the Yarra River, a tunnel and reservoir inlet, Sugarloaf reservoir and dam, a drawoff structure and tunnel to the reservoir pumping station, a water treatment plant and a clear water storage basin and pipeline to the supply system. The Sugarloaf dam, 181 meters high, is constructed of weathered and fresh rock and earthfill (5 million cu meters) from within the reservoir site. The upstream face is protected by 75,000 sq meters of impervious concrete. Inlet and drawoff structures are supported against reservoir banks to avoid the need for building bridges or using boats for inspections. The reservoir has a full supply level of 445 hectares at 178 meters elevation. The water treatment plant will draw from an inhabited catchment with increasing use of agricultural chemicals. Provision has been made for activated carbon filters if water odor and taste control requires them. All roads, pipelines, and transmission lines for the project were placed with care to minimize effects on the environment. (Cassar-FRC)
W81-04903

**AN OPTIMIZED DESIGN METHOD FOR BUTTRESS DAMS,**
Institutul de Constructii din Bucuresti (Rumania).
R. Priscu, A. Popovici, and P. Suprovici.
International Water Power and Dam Construction, Vol 33, No 3, p 29-33, March, 1981. 6 Fig, 8 Ref.

Descriptors: *Dam design, *Design criteria, *Optimization, *Buttress dams, Stress analysis, Computer programs, Algorithms, Concrete dams, Itaipu Dam, Brazil-Paraguay, Rositas Dam, Bolivia.

A computer program was developed to determine the optimum size and shape of buttress dams. Minimum concrete volume was a major criterion. Other considerations were stability against sliding along the foundation surface, limitation or annulment of the vertical stress at the dam upstream toe, dead weight, hydrostatic pressure at different water levels, and geometrical constraints. The program was applied to two large buttress dams, Rositas and Itaipu. Concrete volumes of the optimum profiles for these dams were 8-12% less than optimized profiles with classical linear faces. It was found that performing the optimization in two stages, predimensioning and final dimensioning, was advisable. Two-dimensional stress analysis produced results as good as three-dimensional analysis. (Cassar-FRC)
W81-04906

**LINEAR DECISION RULE IN RESERVOIR DESIGN AND MANAGEMENT. 6. INCORPORATION OF ECONOMIC EFFICIENCY BENEFITS AND HYDROELECTRIC ENERGY GENERATION,**
Purdue Univ., Lafayette, IN. School of Civil Engineering.
M. H. Houck, J. L. Cohon, and C. S. Revelle.
Water Resources Research, Vol 16, No 1, p 196-200, February, 1980. 14 Ref.

Descriptors: *Reservoirs, *Design criteria, Management, *Model studies, Mathematical models, Economic efficiency.

This paper introduces three extensions of the linear decision rule (LDR) model presented in 1969. The first extension is the incorporation of the objective of maximization of net economic efficiency benefits using methods partially described earlier. The second extension is the incorporation of hydroelectric energy production in the LDR model. The third extension is the reconsideration and new formulation of the safe yield of the reservoir system. Computational experience with the extended model is discussed. The extended LDR is shown to be well within the limits of computational feasibility for large reservoir systems of 10 or more facilities with conflicting uses and an objective of maximizing net economic efficiency benefits. (Baker-FRC)
W81-04915

**MAKING PERU'S DESERTS BLOOM.**
International Water Power and Dam Construction, Vol 32, No 2, p 39-41, February, 1980.

Descriptors: *Irrigation programs, *Tunneling, *Hydroelectric power production, Tunnels, Tunnel construction, Irrigation canals, Foreign projects, Arid climates, *Peru, *Water transport.

A five nation consortium has begun work on a vast irrigation and hydro-power scheme which will enable one fifth of Peru's basic foodstuffs to be grown in a former desert and add 656 MW of power. The water of the Colca river will be diverted through a system of tunnels and canals onto the plain. The Condoroma dam will be built 4200 m up the Andes to collect and control flow of the river, which has a seasonal variation of 3.5 cu m/sec during most of the year and 1000 cu m/sec during the December to February rains. This water will also be directed to the tunnel and canal system, which will ultimately distribute the water over 23,000 ha of desert. Stage II of the plan includes construction of a dam at Angostura which will make possible the irrigation of another 60,000 ha. At present, virtually all of the tunneling is complete. Tunneling crews have had problems with water and with swelling rock, an andesitic rock with clay in the fissures which swells when in contact with air, crumbling the face. The Peruvian concrete industry has had some problems keeping up with the demand for concrete to line the tunnels. This year, the first 6000 ha will get the year's soaking it needs before crops can be sown. (Small-FRC)
W81-04990

## 8B. Hydraulics

**CALIBRATION OF A 90 DEGREE V-NOTCH WEIR USING PARAMETERS OTHER THAN UPSTREAM HEAD,**
West Virginia Univ., Morgantown. Dept. of Civil Engineering.
R. Eli, H. Pedersen, and R. Snyder.
Available from the National Technical Information Service, Springfield, VA 22161 as PB80-226269, Price codes: A06 in paper copy, A01 in microfiche. Environmental Protection Agency Report EPA-600/4-80-035, July, 1980. 120 p, 33 Fig, 5 Tab, 15 Ref, 3 Append.

Descriptors: *Weirs, *Calibrations, *Flow discharge, *Discharge measurement, Water depth, Water measurement, Flow measurement.

Traditional calibration of 90 degree V-notch weirs has involved the establishment of a head-discharge relationship where the head is measured well upstream of weir drawdown effects. This parameter is often difficult to measure in field weir installations for checking compliance to discharge regulations. The experimental effort involved the attempted calibration of two additional measurement parameters. The calibration tests, including a statistical error experiment, were successful for the parameters; depth of flow at the weir, and width of flow at the weir. Based on test statistics and experience with the measurement techniques, the depth of flow at the weir notch was the easiest to obtain with the least probability of significant error. However, both techniques resulted in errors in discharge of less than 10% with a probability of 95%. The level of accuracy is deemed sufficient to approve both techniques for field testing. Calibration tables for the standard measurement of head over the weir plus depth and width of flow at the notch are included. (Moore-SRC)
W81-04699

**FLOW MONITORING,**
C. A. McClure.
U.S. Patent No 4,221,127, 6 p, 4 Fig, 7 Ref; Official Gazette of the United States Patent Office, Vol 998, No 2, p 435, September 9, 1980.

Descriptors: *Patents, *Flow measurement, *Monitoring, Flow rate, Pipe flow, Closed conduit flow, Instrumentation, Gravity flow.

The objects of the invention are accomplished by the steps of, first, physically embodying a known relationship, between depth of liquid in the pipe and liquid flow through the pipe, in a system for converting an input value of such depth to the corresponding value of such flow; next, sensing the depth of liquid in the pipe, in the absence of a weir, flume, or other flow-rating device; then inputting the sensed depth value to the conversion system and obtaining the corresponding output flow value, and providing a physical indication of such output flow value. In apparatus terms the invention comprises means for monitoring gravity flow in a pipe without a weir, flume, or other flow-rating device, including a physical system adapted to receive input values of depth of liquid in the pipe and to output corresponding values of liquid flow through the pipe in accordance with a known relationship, means for sensing depth of liquid in the pipe and for transmitting the sensed depth to the input-output system, and means for translating the output into a flow indication. (Sinha-OEIS)
W81-04741

**BED EROSION IN RECTANGULAR LONG CONTRACTION,**
Ahmadu Bello Univ., Zaria (Nigeria). Dept. of Civil Engineering.
M. A. Gill.
Journal of the Hydraulics Division, Proceedings of the American Society of Civil Engineers, Vol 107, No HY3j, p 273-284, March, 1981. 7 Fig, 3 Tab, 6 Ref.

Descriptors: *Channel erosion, *Hydraulic engineering, *Waterways, *Scour, River beds, Rivers, Civil engineering, Channel scour, Watercourses, Channel improvement, Mathematical models.

When the width of a rectangular channel is reduced by building long side walls so that the width within the side walls remains constant, the contracted channel may be called a rectangular long contraction. In order to guard against the destructive effects of excessive erosion within the reach, resulting from increased bed shear stress of the flow, it is important to be able to estimate the depth of maximum erosion. A laboratory study was designed to investigate the general erosion within a long contraction problem and to evaluate the applicability of Straub's theoretical one-dimensional model for general erosion. The study results showed that Straub's simple model can be used for predicting scour depth in a long contraction with reasonable accuracy. For design purposes, the predicted depths should be scaled up by about 58 percent to get a maximum local value. The inlet region close to the walls is subjected to severe local erosion. In order to obtain an estimate of the extreme maximum depth of scour in this region, the theoretical values should be multiplied by 2.56. (Carroll-FRC)
W81-04765

## 8C. Hydraulic Machinery

**INFILTRATION/INFLOW REMOVAL,**
Donnelly, Conklin, Phipps and Buzzell, Inc., Springfield, VT.
G. F. Conklin.
Water/Engineering and Management, Vol 128, No 4, p 34, 36, 37, April, 1981. 1 Tab.

Descriptors: *Infiltration rate, *Sewer systems, Sewer infiltration, *Design criteria, Evaluation, Wastewater facilities, Planning, Monitoring.

This discussion summarizes the findings of a stud that evaluated the effectiveness of the Infiltration/Inflow (I/I) program which was implemented in 18 communities across the country. The purpose of the study was to evaluate construction so as to eliminate or reduce infiltration/inflow that would be costly to transport and treat. The evaluation indicated that in general plans to reduce and eliminate excessive I/I have not been accomplished. Changes are needed in Sewer System Evaluations in order to provide more realistic initial data and ensure more successful projects. Standardization of quantification is needed for systemwide I/I. Monitoring of I/I flow should be performed during wet weather and/or high groundwater conditions. A realistic system I/I rate must be used as a cut-off for projects to proceed to Sewer System Evaluation Surveys. Limited television inspection and rainfall simulation work should be included in the I/I Analysis Phase. The impace of I/I from house service connections and groundwater migration after sewerline rehabilitation should also be considered. Television inspection of flow estimating techniques should be standardized. (Baker-FRC)
W81-04835

**TURBINE BEHAVIOUR UNDER CAVITATION CONDITIONS,**
Trieste Univ. (Italy). Inst. di Macchine e Tecnologie Meccaniche.
A. Antonini, and A. Giadrossi.
International Water Power and Dam Construction, Vol 33, No 3, p 25-28, March, 1981. 9 Fig, 2 Tab, 5 Ref.

Descriptors: *Turbines, *Cavitation, *Hydroelectric plants, Francis turbines, Powerplants, Propellers, Static head, Depression head, Pressure head, Flow rate.

Behavior of Francis and propeller turbines at variable flow, head, and suction head was studied under cavitation conditions. In the Francis turbine the ratio of head at outlet (Ha) to static suction head (Hs) increased with increasing flow coefficient. The propeller turbine showed an opposite trend. With a nominal value of flow coefficient, an increase in head increased outward flow for both machines. As flow coefficient increased, the ratio of Ha/Hs decreased for propeller turbines. In the Francis turbine, increaing flow coefficients corresponded with a rising ratio. A graph of efficiency vs cavitation coefficient was made for different values of Hs and nominal speeds. In the Francis turbine, efficiency increased before the collapse at the cavitation point, whereas the propeller turbine efficiency decreased as cavitation coefficient decreased, operating under unstable conditions throughout the whole process. Although the percentage of revolution variation in the propeller turbine was greater, the flow coefficient varied in a more limited range compared with the Francis turbine. When the flow coefficient is high, the dynamic pressure coefficient is greater for the propeller turbine and there is a risk of cavitation even at low values of the static suction head. The opposite is true when the flow coefficient is low. (Cassar-FRC)
W81-04904

**INTENSE SYSTEM VIBRATIONS IN HYDRO PLANTS,**
Escher Wyss G.m.b.H., Zurich (Switzerland).
A. H. Glattfelder, H. Grein, and P. K. Dorfler.
International Water Power and Dam Construction, Vol 33, No 3, p 34-37, March, 1981. 4 Fig, 2 Tab, 20 Ref.

Descriptors: *Vibrations, *Hydroelectric plants, Planning, Powerplants, *Design criteria, Mechanical engineering, Systems analysis.

A risk assessment chart was developed to help visualize origins, causes, and characteristics of vibrations in hydroelectric plants. Using this chart, high risks may be spotted at an early stage, enabling preventive redesign and modifications. Also, actual and predicted plant vibrations may be compared. Illustrations are given of three cases in plants with Francis turbines. They show how the vibrations are transmitted from the source subsystem into other subsystems, producing critical values far from the source. Three factors which affect the vibrations in a plant are the excitation mechanism, which supplies a periodic output signal; subsystem resonance; and the relative coupling factor between the two. If all three factors are high, then the risk is high that vibrations will reach too high an amplitude. Some typical excitations are (1) hydraulic--vortex flow in draft tubes, destabilizing labyrinth forces, shear flows, and nonuniform flows after cascades consisting of a finite number of blades through which a subsequent lattice with a finite number of runner blades passes; (2) mechanical--out-of-balance, non-cylindrical surface of axis in radial bearing, and oil film instability; and (3) magnetic--oscillating magnetic fields of the motor-generator. (Cassar-FRC)
W81-04905

**MULTIPORT DIFFUSER AS LINE SOURCE OF MOMENTUM IN SHALLOW WATER,**
Delaware Univ., Newark. Dept. of Civil Engineering.
J. H. Lee, and G. H. Jirka.
Water Resources Research, Vol 16, No 4, p 695-708, August, 1980. 17 Fig, 1 Tab, 20 Ref.

Descriptors: *Shallow water, *Diffusers, *Mixing, *Plumes, Cooling water, Fluid mechanics, Flow rate, Water circulation, Path of pollutants.

Multiport diffusers, used in sewage discharge and for disposal of cooling water, are linear structures consisting of many closely spaced nozzles which inject a series of high-velocity jets into an ambient fluid. This paper concerns the analysis of the velocity and temperature field induced by thermal diffusers operating in shallow coastal zones. The flow field can be divided into the near field, about the length of the diffuser, and the far field. The near field has a predominantly inviscid behavior and produces a contracting slipstream motion, similar to that produced by an airscrew. The boundary conditions at the diffuser line are assumed to be a uniform normal velocity and a uniform longitudinal acceleration. Results indicate a strong separation angle (60 degrees) of the slipstream at the diffuser and a rapid approach to the asymptotic contraction value (0.5). Two distinctive features characterize the diffuser plume. First, it shows an exponential loss of fluid momentum through turbulent bottom friction, which leads to an ultimate plume stagnation at a characteristic distance and limits the total lateral entrainment flow. Second, the initial plume characteristics (rate of entrainment) are controlled by the accelerating high-velocity slipstream in the vicinity of the line source. Experimental results obtained in a shallow laboratory basin agree with theoretical results. (Cassar-FRC)
W81-04925

## 8D. Soil Mechanics

**VIBRATION TESTS OF FULL-SCALE EARTH DAM,**
Princeton Univ., NJ. Dept. of Civil Engineering.
A. M. Abdel-Ghaffar, and R. F. Scott.
Journal of the Geotechnical Engineering Division, Proceedings of the American Society of Civil Engineers, Vol 107, No GT3, p 241-269, March, 1981. 18 Fig, 4 Tab, 13 Ref.

Descriptors: *Earth dams, *Vibrations, *Dynamics, Earthworks, Dams, Experimental data, Shear stress, Measuring instruments, Frequency analysis, Dam design.

Full-scale experimentally determined dynamic characteristics of earth dams are required both to improve the techniques by which such properties are calculated for purposes of analysis and design and to permit interpretation of the measured response of earth dams in the event of a strong earthquake. Extensive full-scale dynamic tests, including ambient (unique in earth dam research) and forced vibration as well as popper tests, were conducted on the Santa Felicia earth dam in Southern California. For the forced vibration tests, the dam was excited into resonance in both the upstream-downstream and the longitudinal direction. During the ambient test, the naturally occurring vibrations of the dam were measured. The popper test involved the use of pressure waves originating from a controlled, submerged release of gas. During the tests, three-dimensional measurements of the motions of approximately 25 stations along the crest and 7 stations of the downstream slope were recorded and then analyzed in both time and frequency domains. Modes of vibrations and associated natural frequencies, as well as damping ratios, were determined. (Carroll-FRC)
W81-04776

**DESIGN CONSIDERATIONS FOR COLLAPSIBLE SOILS,**
Syracuse Univ., NY. Coll. of Engineering.
S. P. Clemence, and A. O. Finbarr.
Journal of the Geotechnical Engineering Division, Proceedings of the American Society of Civil Engineers, Vol 107, No GT3, p 305-317, March, 1981. 6 Fig, 2 Tab, 26 Ref.

Descriptors: *Soil properties, *Soil mechanics, *Collapsible soils, Loess, Strength, Soil stabilization, Soil structure, Soil types, Soil strength, Engineering geology.

Metastable or collapsible soils are defined as any unsaturated soils that go through a radical rearrangement of particles and great loss of volume upon wetting, with or without additional loading. Many of these soil deposits are located in predominantly arid regions which are now beginning to develop economically and industrially, making it increasingly important to understand and predict the behavior of these soils. Structures or facilities of any nature constructed on these soils should receive careful attention. The existing types of collapsible soils and theories developed to explain collapse phenomena are reviewed, as are the methods of recognizing collapsible soils in the field and in the laboratory. Prediction techniques for the magnitude of collapse are presented and summarized. Current foundation design methods on collapsible soils are explored. Finally, present methods for the stabilization of collapsible soils and possible future methods of treatment are reviewed. (Carroll-FRC)
W81-04777

**COMPARATIVE STUDY OF DYNAMIC RESPONSE OF EARTH DAM,**
Princeton Univ., NJ. Dept. of Civil Engineering.
A. M. Abdel-Ghaffar, and R. F. Scott.
Journal of the Geotechnical Engineering Division, Proceedings of the American Society of Civil Engineers, Vol 107, No GT3, p 271-286, March, 1981. 5 Fig, 5 Tab, 9 Ref.

Descriptors: *Earth dams, *Dynamics, *Mathematical models, Earthworks, Earthquakes, Dams, Frequency analysis, Experimental data, Shear stress, Vibrations, Engineering geology.

The dynamic response of the Santa Felicia Dam in southern California was investigated to gather full-scale experimental data concerning its low-level dynamic characteristics for comparison with the relatively high-level characteristics resulting from the analysis of the dam's structural performance during two actual earthquake conditions. The measured frequencies and modes of upstream-downstream vibrations are compared with those predicted by an existing two-dimensional shear-beam model. Shear strains and shear moduli were estimated from the full-scale tests and were plotted along with those estimated from the earthquake response analysis. The same procedure was followed for damping versus shear strain at different levels. The combined results were then interpolated and extrapolated to provide a general guide to the material properties of rolled-fill earth dams for both earthquake and geotechnical engineers. The dynamic properties for the dam's constituent materials estimated from low-strain full-scale tests are consistent with those determined from relatively large strains induced by the two earthquakes. Also, the tests revealed substantial change in the dynamic properties of the dam; the behavior is typical of a yielding dynamic system. (Carroll-FRC)
W81-04778

**PROBABILISTIC EVALUATION OF LOADS,**
Illinois Univ. at Urbana-Champaign.
W. H. Tang.
Journal of the Geotechnical Engineering Division, Proceedings of the American Society of Civil Engineers, Vol 107, No GT3, p 287-304, March, 1981. 6 Fig, 1 Tab, 36 Ref.

Descriptors: *Probabilistic process, *Load distribution, *Geotechnical aspects, Mathematical studies, Stochastic process, Pore pressure, Earth pressure, Earthquakes, Wind, Liquefaction, Statistical analysis, Offshore platforms, *Engineering geology.

Although loads are a major input parameter in design, they are usually already prescribed to geotechnical engineers. Significant amounts of uncertainty may arise from spatial as well as temporal fluctuation of load and environmental factors and from the idealized assumptions necessary for evaluating load effects. Although a large proportion of the uncertainties in the load and environmental factors is due to inherent natural variability, an understanding of their variation and statistics is essential to achieve a design that will have a sufficiently high probability of successful performance. This paper reviews the loads that affect geotechnical designs, characterizing the uncertainties in each load component. Probabilistic models for evaluating each component are examined. Whenever data are available, the level of variabilities and uncertainties associated with the effect of each component on the foundation is assessed. Load components which are considered include permanent static load, regular occupancy load, extraordinary loads, soil-induced loads, and pore pressure and seepage force. For dynamic loads due to earthquake excitation and wave action, neither the magnitude nor the frequencies of occurrence over the expected duration of the system could be determined. The long-term stability of soil slope is also dependent on stochastic fluctuation of the pore pressure due to seasonal variation and other temporal changes in the environment. It is concluded that with properly formulated probabilistic models and adequate statistical data, the probability of encountering a certain magnitude of load or load combination over a foundation's lifetime can be evaluated. This information is necessary in rational planning of geotechnical systems and in the establishment of load values for design purposes. (Carroll-FRC)
W81-04779

**GEOTECHNICAL CONSIDERATIONS FOR CONSTRUCTION IN SAUDI ARABIA,**
Converse Ward Davis Dixon, Caldwell, NY.
I. Oweis, and J. Bowman.
Journal of the Geotechnical Engineering Division, Proceedings of the American Society of Civil Engineers, Vol 107, No GT3, p 319-338, March, 1981. 14 Fig, 2 Tab, 3 Ref.

Descriptors: *Geotechnical aspects, *Construction, *Soil mechanics, *Saudi Arabia, Geotechnical engineering, Civil engineering, Geological surveys, Rocks, Salinity, Soil properties, Corrosion, Construction materials, Construction methods, Middle East, Engineering geology.

Engineering firms and contractors competing for construction contracts in Saudi Arabia require a prior knowledge of ground conditions in Saudi Arabia not only for developing a proper basic design but also to assure that the construction is compatible with environmental geology. A general knowledge of topography, climate, and bedrock geology is essential to the assessment of ground conditions in Saudi Arabia, since these factors control the development of surface soils and rocks. Several geologic environments prevail in Saudi Arabia. Problems in design and construction are intimately related to the environment at particular locations. Coastal areas are generally characterized by particularly soft and loose corrosive soils. Limestones in the interior are characterized by the potential for the presence of dry cavities and solution channels. Igneous and metamorphic rocks of good bearing quality characterize the high mountains overlooking the west coast; superimposed areas of sand dunes and salt flats could present special foundation problems. The availability of construction materials depends on bedrock geology and varies from relatively good in the western areas to poor in the eastern region. Offshore conditions in western coastal areas are characterized by varied subsurface conditions at relatively short distances, affecting the design of offshore facilities, while offshore conditions are more uniform along the Persian (Arabian) Gulf. (Carroll-FRC)
W81-04780

**SAFETY OF A CONSTRUCTED FACILITY: GEOTECHNICAL ASPECTS,**
Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
T. W. Lambe, W. A. Marr, and F. Silva.
Journal of the Geotechnical Engineering Division, Proceedings of the American Society of Civil Engineers, Vol 107, No GT3, p 339-352, March, 1981. 7 Fig, 2 Tab.

Descriptors: *Safety, *Dam construction, *Geotechnical aspects, Earthworks, Earth dams, Pore pressure, Water pressure, *Design criteria, Risks, Soil properties, Performance evaluation, Prediction.

Civil engineers must give priority to the safety of the facilities they design and help construct. Economic considerations often require that geotechnical engineers use lower factors of safety than those used by the structural engineer, despite the fact that the properties of soil, the geotechnical medium, vary more than those of steel, concrete, and wood. As a result of the relatively low safety factors, the geotechnical engineer must employ greater supervision and review of construction and surveillance of operations than do other engineers in order to help ensure the safety of their constructed facilities. An approach is presented to ensure the safety of a constructed facility by outlining, discussing, and illustrating various components of a comprehensive safety program. The program's systematic approach is based on the fundamentals of geotechnical engineering, including the effective stress principle, the stress path method, Darcy's Law, and stress-strain principles. Successful application of the program yields a portrayal and evaluation of actual performance, an assessment of prediction capability, and a reservoir of evaluated performance, including data on the effectiveness of remedial work. Experience clearly shows that the geotechnical profession cannot feasibly create a complex geotechnical facility which completely fulfills all performance criteria for the entire life of the facility. Rather, the only logical approach is to engineer a facility for its design life, create a reasonable design, construct the facility according to the design, and then execute an appropriate ongoing safety program. (Carroll-FRC)
W81-04781

**CONSTRUCTION OF LARGE CANAL ON COLLAPSING SOILS,**
Water and Power Resources Service, Denver, CO. Div. of Research.
For primary bibliographic entry see Field 8A.
W81-04800

**A BRIEF REVIEW OF FOUNDATION CONSTRUCTION IN THE WESTERN CANADIAN ARCTIC,**
Alberta Univ., Edmonton. Dept. of Civil Engineering.
S. Thomson.
Quarterly Journal of Engineering Geology, Vol 13, No 2, p 67-76, 1980. 15 Fig, 12 Ref.

Descriptors: *Permafrost, *Ice, *Foundation failure, *Cold weather construction, Frozen ground, Soil types, Arctic, Cold regions, Canada, Construction, Subsidence.

Construction of foundations in permafrost must consider the temperature profile of the subsurface, its variation with time, its response to changes, and the strength and deformation properties of the frozen soils. In Canada permafrost is found everywhere north of the line running northwest to southeast from near Inuvik to South Hudson Bay. South of this is a 400-800 km wide zone where patches of frozen and unfrozen ground appear. There is a gradual transition from north to south. Soil ice should be considered as a soil type and be carefully studied before beginning design and construction. Several examples of subsidence and tilting of foundations in heated buildings are related. Since these failures were caused by melting of ice-rich soil from building heat, foundations in such soil should be constructed with piling, spread footings, posts and pads, ducts, artificial refrigeration, and/or a rigid structural base. Highways, subjected to only seasonal thawing, need only be thick enough to contain the summer thaw within the

stable fill. Insulation reduces the total amount of fill required. (Cassar-FRC)
W81-04857

## 8E. Rock Mechanics and Geology

**REBOUND, ITS NATURE AND EFFECT ON ENGINEERING WORKS,**
Geological Survey, Denver, CO.
T. C. Nichols, Jr.
Quarterly Journal of Engineering Geology, Vol 13, No 3, p 133-152, 1980. 10 Fig, 1 Tab, 76 Ref, 3 Append.

Descriptors: *Rebound, *Rock properties, *Erosion, Rock excavation, Excavation, Civil engineering, Mining engineering, Engineering, Geologic fissures, Deformation, Stress, Design criteria.

Rebound of rock masses, the expansive recovery of surface crustal material as a response to removal or relaxation of loads, is found in most geological terrains. Rebound, which may occur instantaneously, time dependently, or both, can follow natural processes, such as valley erosion, or artificial processes, such as excavation. Rebound resulting from erosion is more fully-developed and produces larger displacements, greater weakening of the rock fabric, and denser and more extensive fractures. In clay and shale terrains, valley downcutting can be 10% of valley depth and can produce raised valley rims, movement of walls and anticlines, and fracturing. In interbedded sandstone, limestone, and shale areas, thrust faulting, shearing, and folding are seen near valley bottoms, and extensional fractures are observed in valley walls. Sheeting fractures are common in granitic and metamorphic rocks. Excavation causes severe deformations and failures. In some cases, problems of slope failures and structural damage continue for years after construction. The rebound process (time of rebound, strength decay, and fracture development) should be considered in engineering design criteria. (Cassar-FRC)
W81-04854

**DESIGN OF FOUNDATIONS OF DAMS CONTAINING SOLUBLE ROCKS AND SOILS,**
Binnie and Partners, London (England).
A. N. James, and I. M. Kirkpatrick.
Quarterly Journal of Engineering Geology, Vol 13, No 3, p 189-198, 1980. 3 Fig, 8 Tab, 20 Ref.

Descriptors: *Dam foundations, *Rock properties, *Design criteria, *Solubility, Foundation rocks, Dam design, Soil physical properties, Physical properties, Calcium carbonate, Sodium chloride, Gypsum, Calcium compounds, Seepage control.

The four major classes of soluble rocks to be considered at dam sites are represented by the minerals, gypsum, anhydrite, calcium carbonate, and halite. Most soluble is halite, 360 kg per cu meter in pure water at 10C. Solubilities of the other minerals are on the order of 2 kg per cu meter or less. To prevent settlement and leakage in dam foundation, engineering solutions must consider solubility and specific rate of solution of the minerals and the hydraulic conditions imposed on the foundation. Maximum fissure width (one fissure per meter and a hydraulic gradient of 0.2) to retain 100 year stability is as follows: gypsum, 0.2 mm; anhydrite, 0.1 mm; halite, 0.05 mm; and limestone, 0.5 mm. Site investigation procedures should produce the following information about a dam site: permeability, volumetric proportion of soluble mineral, distribution of soluble mineral, and particle size. These figures may be obtained by analyzing disturbed, tube, or core samples. No dams should be built on massive halite. If halite is suspected, groundwater should be tested for chloride, and then drilling with a T.I.R. or Mazier barrel should be used for further tests, since normal wet drilling can fail to reveal halite's presence. Control measures, (cutoffs, upstream blankets, etc.) must be used if building proceeds in a halite area. Anhydrite requires high-efficiency cutoffs to produce a stable structure resistant to dissolving. Gypsum is useable with a sulfate resistant cement grouting program. Calcium carbonate rock is satisfactory if normal seepage control measures are used. (Cassar-FRC)
W81-04856

## 8G. Materials

**PROPERTIES AND LONG-TERM BEHAVIOR OF ION EXCHANGE MEMBRANES,**
Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Geesthacht-Tesperhude (Germany, F.R.). Inst. fuer Werkstofftechnologie und Chemie.
K. Kneifel, and K. Hattenbach.
Desalination, Vol 34, No 1/2, p 77-95, July-August, 1980. 7 Fig, 3 Tab, 12 Ref.

Descriptors: *Permselective membranes, *Desalination apparatus, *Ion exchange, Wastewater treatment, *Membranes, Water treatment, Cations, Anions.

Fourteen cation exchange membranes and 17 anion exchange membranes were evaluated under uniform conditions so that these commercial products can be compared when selecting membranes for water desalting, wastewater treatment, and recycling of chemical process solutions. Characteristics measured were permselectivity, electrical resistance, ion exchange capacity, transference number, and water content. Membranes were also exposed to distilled water, 0.2 N NaCl, 0.1 N NaCl, 0.1 N nitric acid, and 0.1 N NaOH at room temperature for up to five years. Most membranes retained permselectivity up to 100 days. Capacities were reduced to less than 60% in longer trials. At 85C all membranes but two were destroyed. (Cassar-FRC)
W81-04878

## 8I. Fisheries Engineering

**AQUACULTURE TECHNIQUES; OXYGEN (PO2) REQUIREMENT FOR TROUT QUALITY,**
Idaho Water and Energy Resources Research Inst., Moscow.
P. C. Downey, and G. W. Klontz.
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-238560, Price codes: A03 in paper copy, A01 in microfiche. Research Technical Completion Report, February, 1981. 42 p, 5 Fig, 16 Tab, 29 Ref. OWRT-A-069-IDA(1), 14-34-0001-0114.

Descriptors: *Oxygen requirements, *Oxygen concentrations, *Dissolved oxygen, *Aquaculture, *Aquatic environment, *Salmonids, Trout, Instream flow, Water temperature, Water level.

The study was designed to consider perceived limitations in determining minimum dissolved oxygen criteria for aquatic environments. Its objectives were: (1) explain how oxygen functions in aquatic environments with different water temperatures at different elevations; (2) determine whether solubility (mg/l or percent saturation) or partial pressure (pO2) would more appropriately express minimum oxygen requirements of aquatic systems; (3) determine dissolved oxygen tensions below which rainbow trout growth rates are retarded; and (4) demonstrate practical application of minimum oxygen tension for hatchery practices. It was concluded that oxygen consumption by fish is not directly dependent on oxygen solubility per se, but on an environmental partial pressure of oxygen greater than 90 mmHg. Minimum oxygen concentrations for maintenance of allowable growth and for determining environmental requirements for instream flows can be determined from this figure. Available oxygen can be calculated using the formula: AO=DOsat - DO90, where AO is available dissolved oxygen; DOsat is the mg/l dissolved oxygen in water at a particular elevation and temperature and DO90 is mg/l dissolved oxygen at partial pressure of 90mmHg. Inclusion of both concepts (solubility and partial pressure) into carrying capacity models enhances their flexibility to deal with various temperatures and elevations. (de Coquereaumont-IPA)
W81-04655

**BIOMANIPULATION AND LAKE RESTORATION ON STATE WATERS IN ILLINOIS,**
Illinois Dept. of Conservation, Spring Grove.
For primary bibliographic entry see Field 5G.
W81-04763

**FACTORS INFLUENCING SMALLMOUTH BASS PRODUCTION IN THE HANFORD AREA, COLUMBIA RIVER,**
Battelle Pacific Northwest Lab., Richland, WA.
J. C. Montgomery, D. H. Fickelsen, and C. D. Becker.
Northwest Science, Vol 54, No 4, p 296-305, November, 1980. 6 Fig, 1 Tab, 9 Ref.

Descriptors: *Fish, *Water level fluctuations, Water discharge, Water level, Spawning, *Bass, *Columbia River, Rivers, River flow, Hydroelectric plants, Seasonal variation.

This report summarizes observations and data on residence periods of smallmouth bass in spawning areas, spawning activity, movements during and after spawning, and entrapment and desiccation of juvenile bass in the Hanford Area of the Columbia River, Washington State. Some effects of water level fluctuations are evaluated. From April through June the adult bass spawned in warmed sloughs and backwater areas bordering on the Columbia River. In August of 1976 and in late June of 1977 they returned to the main river channel after spawning. The movements of the bass appeared to be regulated to some degree by the water level in the river, water depth, current, and available forage organisms. High river levels adversely affected spawning success, as the water flooded nest sites with cool water and caused other perturbations. Fluctuating river flows did lead in some cases to loss of young due to entrapment, predation, thermal and oxygen stress and desiccation. Seasonal water regimes in the Columbia River governed the adverse ecological factors for the most part; however, some influence was also felt from the interseasonal fluctuations in flow levels caused by hydroelectric power generation at Priest Rapids Dam. (Baker-FRC)
W81-04931

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